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THE

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I. HYLOZOIC MATERIALISM.

Communicated by ROBERT LEWINS, M.D.

"Audi alteram partem."

THE two chief opponents by whom the Materialist is encountered are the negatively Agnostic *savant** and the Christian divine; yet his theorem is simply a logical deduction from the fundamental principles of Science and Theology. Of Science, which cannot logically assume two causes where one is sufficient, and must therefore deny that matter, being essentially active, needs to be "inspired" by a vital [or motor] principle; of Theology, which, by postulating the existence of one Infinite *Omnipresent* Deity, in whom we "live and move and have our being," destroys, at the very outset, all distinction between body and soul, between God and the world. This last result of insight and reason is also the first dictate of instinct and nature, for every child, every savage, every simple and healthy human being is an unconscious Materialist. Yet although this Hylozoistic thesis is at once the expression of primitive feeling, the legitimate product of modern Physics, and the scientific equivalent of ancient Pantheism, it has been met, by learned and ignorant alike, with greater antagonism and anti-sympathy than have been accorded to any other theory

* Of living *savans*—not to mention the great shades of Newton, Sir John Herschell, Brewster, and Faraday—who are supporters of Animism, may be mentioned the distinguished names of the Astronomer-Royal, Sir George Airey, the Lucasian Professor Stokes, Professor Adams, the discoverer of the planet Neptune, Mr. St. George Mivart, Professor Lionel Beale, Mr. Crookes, Mr. Wallace, &c.

of the universe. Though it is exemplified in their practical conduct, and implicitly recognised in their habits of thought and sentiment, they shrink with repugnance from its verbal exposition. Lately, however, it has forced itself upon public attention, and become an object of more calm and respectful criticism; and I here propose briefly to examine the principal objections with which it now has to deal, and to endeavour to estimate their force. They resolve themselves into these:—1st. That as man can know nothing beyond phenomena, he cannot absolutely deny the existence of an immaterial principle, or soul, animating the material body. And 2nd. That matter is, in its essence, inert, and therefore incapable of sensation and thought.

A little reflection will show that these two positions are mutually destructive, as the latter, which is purely metaphysical, claims for man not only a *positive*, but a *negative* knowledge of noumena. Though he cannot predict how Nature *will* behave under every possible combination of circumstances, he is yet capable of deciding how she will *not* behave. Except from his own sensations, he can learn nothing of the potencies of matter, yet he feels justified in assigning them a certain boundary, and declaring that they shall go thus far and no farther.

It is evident that we can obtain nothing from an idea which we have chosen to exclude from it; and if we arbitrarily limit the attributes of matter to extension and impenetrability, there will be a large class of phenomena which lie without the sphere of our science, and appear to be of supernatural or spiritual origin. But we are assured by the Law of Gravitation, as formulated by Newton and Laplace, that *energy* is as inseparable from every particle of matter as impenetrability itself; and this single addition to our idea supplies the place of all former animistic theories. The force which sustains and guides the orbs of heaven is not a distinct or external entity, but is immanent in every atom of their mass; and this "generalisation from the Newtonian discovery cannot be restricted to 'brute' matter; it is equally applicable to the organic kingdom of Nature, to plants, animals, and man. . . . The question of the *anima mundi* and *anima humana* (using the term in the sense of soul) is at bottom one and the same."*

In Mr. Barker's first article on "Life and its Basis," in the January number of the "Journal of Science," he justly

* Life and Mind on the Basis of Modern Medicine, by R. Lewins, M.D., reviewed in the "Journal of Science" of November last.

remarks that "the belief that matter is, *per se*, *passive*, carries with it the belief in creative acts." It is not less true that the certainty that matter is, *per se*, *active*, renders all such beliefs—including the hypothesis of a distinct, immaterial, vivifying agency—both superfluous and absurd. Dualistic philosophy is deprived of its *raison d'être* by the removal of the sharp distinction between death and life, and by the theorem that both are diverse manifestations of one and the same energy. And this furnishes a reply to one of the objections mentioned at the beginning of this article, that, namely, which derives its force from the supposed impossibility of proving a negative. Total want of evidence is equivalent to *disproof*, and is practically so considered.

If we cannot deny the existence of the "soul," neither can we deny that of fairies, goblins, ghosts, or of the genii or "ruling angels," * which were anciently believed to inhabit the planets and regulate their orbits. Yet it would scarcely be considered a wise exercise of scientific scepticism to suspend our judgment upon the truth of the "Arabian Nights." Nay, more; there is an immense mass of legal and other evidence in favour of the reality of witchcraft; but since we see that all its supposed effects may be produced by natural causes in the province of Nosology, and since the supernatural explanation is out of harmony with our present habits of thought, we contemptuously dismiss a doctrine held by many generations of intelligent men, and never, except inferentially, disproved. We may, in the same manner, dismiss from serious consideration that invisible, intangible, indemonstrable entity, whose supposed function as an animating principle is fully discharged by the *vis insita* of matter alone. The innate force which sustains the mechanism of the universe is surely sufficient to produce all the phenomena of animal and vegetable life, more complicated, but not more mysterious, than the motion of the earth round the sun, or the falling of a stone to the ground. But it may be urged that, even taking into account this inherent energy, it is impossible to explain the powers of properties of organic by those of inorganic bodies. It may be said that mental and moral faculties "are not qualities of *matter*, not even of *living* matter, or they would be exhibited by plants and trees as well as animals." This is certainly true. There is nothing in a lump of earth, or even in a blade of grass, which can lead us to suppose that its

* *See* POPE's line in his "Essay on Man":—

"Let ruling angels from their spheres be hurl'd."

constituent atoms will ever become part of a sentient organism. But no argument can be drawn from this truism, unless we assume that the most easily ascertainable properties of any substance enable us to predict its behaviour under all possible conditions. If this were so, the laws of one science would afford the complete *rationale* of every other, and we might have discovered the electric telegraph by means of the Law of Gravitation, and the composition of water by the principles of Hydrostatics. But even directly related phenomena flatly contradict such an assumption. The cause refuses to account for the effect,—the effect to reveal the cause. This truth cannot be more strikingly illustrated than by the modern science of Chemistry. From the individual properties of any two elements we can neither infer *à priori* nor explain *à posteriori* the result of their union. In following the history of any chemical compound, we meet with phenomena not less wondrous and inexplicable than those of Life and Consciousness. I select a well-known example:—Nitrogen and carbon, two inodorous and innoxious elements, unite to generate cyanogen, an extremely poisonous gas, emitting a peculiar and penetrating odour, and producing, in combination with oxygen, six isomeric compounds. One of them, cyanic acid, is a clear and strongly odorous liquid, which cauterises the skin like red-hot iron, but in a few hours spontaneously solidifies into cyamelide, an opaque white solid, inodorous, and without acid qualities. Here it is evident that the constituent atoms no more possess the qualities of the compound than the molecules of the brain are individually endowed with the powers of judgment and reflection. Yet we do not find it necessary to assume the addition of a poisonous and odorous immaterial principle to the compound cyanogen, nor the exit of such an entity from cyanic acid, when it is transformed into its isomer.

The science of Chemistry may, indeed, fittingly illustrate that of Biology, for the vital act itself is a purely chemical process. The life of man is identical with the life of a flame, being maintained by the oxidation, or slow combustion (eremacausis), of organic tissue, at a temperature of 98° F. The oxygen, which but a moment before formed part of the apparently non-vital atmosphere, imparts vitality to the human frame, with which it is for a time incorporated. Being absorbed by the blood in its passage through the lungs, it is conveyed by heart and arteries to the network of infinitesimal capillaries, and from these to every atom of the living body, where it at once integrates and disintegrates, constructs

and destroys. Life waxes or wanes as this non-incandescent fire burns with more or less activity, and ceases with its extinction. Its feebleness in old age causes a corresponding decline in keenness of sense and intellect, and in strength of character; for chemical conditions exercise the same control over moral and mental powers as over those which we have been accustomed to distinguish as purely physical. The function is uniform, the product diverse; for secretion, in all its forms, muscular motion and consciousness are but different results of the same invisible antecedent process, which alone sustains and vivifies "body, soul, and mind." Thus the "cellular vitality" is really identical with that of the conscious brain, and the living corpuscle perfectly typifies the living organism, of which it is a microscopic constituent. The relation is that of Microcosm and Macrocosm. This fact disposes at once of the distinction between that "corpuscular life" which is common to animals and plants, and the "anima" which a consistent dualist must believe to reside in the lowest form of organised matter capable of sensation and volition.* The first dawn of consciousness is not more easy of explanation than the subtlest processes of human thought, and both must evidently be traced to the same origin, viz., to the inherent energy of matter, manifesting itself in more or less complex organisms. To regard sensation as proceeding from a super-material essence—a *donum divinum* superadded to organisation—rather than from that physical development of nerve tissue with which it is invariably associated, is to prefer hypothesis to thesis, fable to fact.

It must be difficult, even for the most ardent dualist, to believe that, although the mental and moral faculties may appear to be irretrievably impaired by a serious injury to the cerebral hemisphere, the soul yet remains intact, and will be restored to more than pristine vigour by the final destruction of that corporeal mechanism whose *partial* disintegration has already paralysed will, emotion, and thought.

* The so-called process of "assimilation" carried out by plants is, of course, the direct reverse of animal respiration; yet in both cases vitality is sustained by a chemical process; and it must not be forgotten that vegetables also respire, and that, although they absorb oxygen in relatively small quantities, it is not less necessary to their life than to that of animals. Perhaps I may be excused for referring here to a statement in Mr. Barker's article, which I cannot but suppose must have been inserted by some inadvertence. He asserts that, while animal forms of protoplasm comprise all four of the elements,—carbon, hydrogen, oxygen, and nitrogen,—"vegetables, with a few exceptions, contain only the first three." It is a fact well known, not only to the botanical chemist, but to the practical agriculturist, that vegetable protoplasm *invariably* contains nitrogen, and that crops will not thrive if the soil be deficient in nitrogenous substances.

Every medical practitioner acts on the material theory of mind, just as every Evolutionist implicitly asserts it. The Darwinian and any other modern theory of Evolution *must* be essentially materialistic, since the continuity of the chain of life, from yeast-cell to man, leaves no point where we can assume the intervention of a spiritual entity, modifying or "inspiring" the physical organisms. That the bee has a soul denied to the flower on which it feeds, that man has a spirit to which his dog can lay no claim, cannot logically enter into the "scientific imagination" of our age.

I must here venture to protest against Mr. Barker's assumption that the "initiation of the living state in the lifeless, whether it has formerly been alive or not, must be due to the action of an unseen higher power." As at present observable, such initiation is a process controlled or regulated by ordinary material conditions, though these are too complex to be formulated into definite laws. In what manner the "*vis insita*" of matter may have manifested itself under palæontological conditions it is impossible to determine. It is likewise impossible to affirm or deny the existence of a Supreme Intelligence or Pantheos; but such a conception is plainly inconsistent with Dualism, and can only be founded on the sublime Hylozoistic conception of the Universe. Man has created God in his own image; but he cannot conceive his Deity to be all in all, and truly omnipresent, until he has recognised the sentient and non-sentient Cosmos as an indivisible and homogeneous unity.

C. N.

II. THE BORDER-LAND OF CHEMISTRY AND BIOLOGY.

IT has become an almost trite saying that just as important minerals are most readily discovered along the meeting-line of different geological formations, and as animal species are most numerous along the edge of the forest or of the river, so the most interesting results are often obtained along what may be called the boundary of two sciences. Of this truth a striking instance is afforded by the researches of Dr. James Blake. This experimentalist has for forty years been engaged with the study of a class of

phenomena having both a chemical and a biological aspect, and he has obtained results of great value alike to organic and inorganic science. As far back as 1839 he showed, in a paper read before the Academy of Sciences in Paris, that the physiological action of solutions of different salts injected into the blood of living animals depended mainly upon the electro-positive or basic element of each salt, and were little modified by the electro-negative element or acid. Thus, to take a simple instance, the effects of sodium sulphate differ less from those of sodium nitrate than they do from those of magnesium sulphate.

Again, in a memoir communicated to the Royal Society, in June, 1841, Dr. Blake proved that the action of inorganic substances conveyed directly into the blood of living animals depended on their isomorphous relations,—those bodies which can replace each other in a crystalline compound without disturbing its form having similar physiological action.

A third step was taken in a discourse delivered before the California Academy of Sciences in 1873, the author showing that among metallic bodies the physiological activity of those belonging to one and the same isomorphous group is proportionate to the atomic weights; the higher the atomic weight the more intense is the physiological action.

Finally, in a paper communicated to the German Chemical Society, on February 7th of the present year, Dr. Blake sums up the whole of his results. The first point to be noticed is that the effects obtained were the same in all the species operated upon—horses, dogs, cats, rabbits, geese, and hens. It might, indeed, have been wished that some ruminant animal and some species of monkey had been inserted in the list. The hedgehog, also, in virtue of his alleged immunity from the action of poisons, would have been a desirable subject. Some cold-blooded animal, such as that "martyr of science" the frog, should have been included. These omissions are the more to be regretted since any extension or verification of Dr. Blake's researches is now rendered practically impossible. So far, however, as experiment has gone, we may conclude that the indifference of certain animals to the action of various poisons when introduced into the stomach is due mainly to non-absorption.*

The substances employed were salts of forty-one of the

* This view can scarcely be admitted in case of the remarkable toleration of the salts of morphine in certain apes. That it really enters the circulation is proved by its subsequent appearance in their urine.—Ed. J. S.

chemical elements. They were dissolved in water, and injected into a vein or artery in known quantities. The fatal doses for each individual were carefully noted, and a kymograph was connected with the femoral artery. The curves described by this instrument were strikingly characteristic for some of the isomorphous groups.

Among the monatomic metals tried were lithium, sodium, rubidium, thallium, and silver. All agreed exactly in the mode of their physiological action, but the fatal dose for rabbits, which was 1 grm. per kilo. of the weight of the animal for lithium sulphate, fell to 0·06 grm. for silver nitrate. In other words, lithium sulphate, to kill, must be introduced in the proportion of 1 part per thousand of the living weight, whilst of silver nitrate 6 parts per 100,000 suffice.

Among the group of the diatomic metals Dr. Blake experimented with the salts of magnesium, iron, manganese, cobalt, nickel, copper, zinc, and cadmium. Here, again, the physiological action is similar, the fatal dose being 0·97 grm. per kilo. for magnesium sulphate, and only 0·08 grm. per kilo. for cadmium sulphate.

The salts of calcium, strontium, and barium agree also in their physiological action, which is intensified from 0·47 grm. per kilo. in calcium chloride to 0·043 grm. in barium chloride. The salts of this group produce contractions of the voluntary muscles, even thirty to forty minutes after the action of the heart has ceased. The reactions of lead salts resemble exactly those of the barium group, but at the same time they agree in some respects with those of the salts of silver.

Among the tetratomic metals the author examined those of thorium, palladium, platinum, osmium, and gold. All have very intense physiological action, ranging from 0·029 grm. per kilo. in thorium sulphate to 0·003 grm. for gold chloride. The characteristic of this group is their effect on the action of the heart. Salts of gold introduced into the blood, even in the minute proportion of 0·003 or 0·004 grm. per kilo., keep up the action of the heart for several hours after death, though the body may have cooled down as far as 55° F. below its normal temperature. We may here ask if this is not the explanation of the action of platinum chloride in prolonging the life of animals bitten by the cobra?

Among the hexatomic metals the salts of glucinum, aluminium, and iron (ferricum) were found to agree in their physiological action, the death-dose being 0·023 grm. per

kilo. in the first, 0·007 in the second, and 0·004 for iron, all in the form of sulphates.

Here we are, in the first place, struck with the difference between iron in its two classes of salts, the ferrous and the ferric. Of the former the fatal quantity is 0·115 grm. per kilo., or twenty-eight times as much of the latter.

We next perceive that the distinction between poisonous and non-poisonous substances is reduced to a mere question of proportion. The dogma that "whatsoever is poisonous in large doses is poisonous also in the smallest, though the injury done may escape notice," falls at once to the ground if we reflect that the very salts which naturally occur in and form necessary parts of our blood become deadly in a somewhat larger quantity!

Among the non-metallic bodies the compounds of chlorine, bromine, and iodine were found accordant in their physiological reactions, but the increase of intensity accompanying the atomic weight was not observed—a most puzzling exception. The identity of action here noted is also peculiar, since bromides taken internally have a very different action from the corresponding chlorides, *e.g.*, in the treatment of sea-sickness. Phosphorus, arsenic, and antimony occasion no immediately perceptible physiological reaction, though if arsenious acid is injected in the proportion of 0·56 grm. per kilo. it arrests the pulmonary circulation. Sulphur and selenium agree in their physiological action; the latter, having the higher atomic weight, is the more powerful.

A curious exception to the rule that isomorphous substances agree in their physiological action is afforded by the salts of potassium and ammonium. The effects of the latter approach those of certain nitrogenous alkaloids.

The author suggests that if—as is far from impossible—the carbon-compounds present similar phenomena in their influence upon animal life, a new key to the molecular relations of organic bodies is placed in the hands of the chemist. It is especially to be remembered that in alcohols of one and the same series the intensity of the physiological action rises with the atomic weight, as has been shown by Dujardin. The question in what manner the isomorphous relations and the atomic weights of substances can influence their physiological action can scarcely as yet be entertained.

Still Dr. Blake's researches are exceedingly valuable, both as pointing out a new method of chemical research and as overturning certain erroneous conceptions concerning the nature of poisons.

III. SCEPTICISM IN GEOLOGY.

By Robert Ward.

"SCEPTICISM in Geology" is the title of a small volume which was published in 1877, under the pseudonym of "Verifier." Its object is declared to be the overthrow of the doctrine enunciated by Lyell, that "the forces now operating upon the Earth are the same in kind and degree as those which in the remotest times produced geological changes;" and the author argues that, if Nature were still carrying on the operations by which the globe was made and fashioned, we would be "entitled to expect to catch her in the act of producing some of those *elementary* substances which enter into the composition of the Earth's crust; not of depositing, but creating the metals and simple minerals, gold, silver, tin, quicksilver, iron, the diamond, emerald, &c.;" but he affirms that "In no instance has any such discovery been made." "Of comparatively recent origin," he continues, "is the theory of Metamorphism, or the alteration and conversion of one kind of rock into another, on a large scale and over great areas. By it sandstone has been (or may have been) converted into quartz rock, or even into granite [?], shales into mica-schists, and fossiliferous limestone into crystalline marble. That such effects have been produced in a former condition of the Earth we have full evidence. The question is how it was effected. About this geologists are much perplexed and greatly at variance; some attributing it to great heat under pressure, others to chemical action. To some, hot water charged with chemical carbonates seems to have been the agent; to others, cold water percolating the rocks. Another expounder writes: 'Heat aided by water is necessary to *allow of internal movements in the rocks* by the softening of their materials, without which I do not see how complete rearrangement of matters accompanied by crystallisation could take place;' but he adds, 'how to obtain the required heat is a difficulty.'"

"Verifier," not having caught Nature in the act of producing elementary substances, and finding that geologists are not agreed as to the processes by which one kind of rock has been converted into another, says that "One thing at least is clear, that the *modus operandi* is neither satisfactorily explained nor approximately understood." This is a very

natural inference; but the fact that geologists have failed to satisfactorily explain the cause of an alleged phenomenon by no means warrants the assertion that it has no existence. And yet this is the position taken by "Verifier," who further declares that "Metamorphism is a thing of the past, its processes not discoverable, and it must therefore be dismissed from the category of 'Causes now in action.'" But it may be answered that the reason why scientists have hitherto largely failed to recognise the metamorphosis which is perpetually taking place in Nature, or "to catch her in the act of producing some of those elementary substances which enter into the composition of the Earth's crust," is due to the fact that such changes are everywhere and at all times present. We do not visually *see* the sapling growing into a tree, or the child transforming into a man; our perception is not sufficiently acute to discover such slow processes; and if the inhabitant of another world were to visit this Earth for a short time only, he might leave with the idea that an oak sapling and an oak tree were two distinct forms of existence. Nevertheless "Verifier" will not deny that, if the fitting conditions are present, the oak sapling will grow into the oak tree.

In an article on "Heat and Light," which appeared in the "Journal of Science" for November last, I showed that everything in Nature is continually undergoing change. This change is indirectly recognised in the statement that all things are growing older. We are accustomed to refer this effect to the influence of Time, but time is a mere abstraction—man's recognition of the change which is in every direction perpetually going on, and not *in itself* an actual force in Nature. When, therefore, we say that time has produced some observed result, we simply mean that to our perception the change in the recognised direction is greater than in some other in which the contrast between the past and the present is unseen or less apparent, and not that any part of Nature has stood still. If we once admit that gold, iron, or any other elementary substance, is by circumstances in the slightest degree liable to change,—and that they are so liable, according to the knowledge we have of them as communicated to our consciousness by the senses, is beyond dispute,—we must conclude that further change to an unlimited extent is only a question of the absence or presence of the necessary conditions. The criticism of "Verifier," however, is perfectly sound when applied to those who, whilst arrogantly proclaiming the transmutation of species, insist upon the "eternal and imperishable" nature of

matter, out of which species and all other things are said to be formed. As a sceptic, he is indeed in many directions unanswerable; but fails greatly when, relinquishing his assumed character, he sets up as a teacher.

Whilst admitting that the *modus operandi* by which the forces now operating are producing geological changes the same in kind and degree as those in the remotest times is not satisfactorily explained by Sir Charles Lyell, I nevertheless believe that the several processes propounded by him have—subject to some correction—performed a part in producing existing results. "The Unity of Nature," so ably elucidated in the "Contemporary Review," by the Duke of Argyll, is so complete that whatever affects a part must exercise an influence—though not necessarily apparent to our senses—upon every other part; and hence it is often difficult to determine what may be logically described as secondary causes, and what may be more correctly recognised as primary. In my book on "The Constitution of the Earth" I have propounded certain laws which are observable in all the changes of Nature, and which, in connection with known phenomena, lead to the conclusion that the Earth has been derived from the Sun by a progressive development still in operation; a conclusion entirely consistent with the formula of Lyell, that "the forces now operating upon the Earth are the same in kind and degree as those which, in the remotest times, produced geological changes." I believe, however, that the Earth is a growing body, and that such vitality as the term expresses may be properly described as the primary cause of the several secondary processes which have issued in its existing biological and geological condition.

"Verifier" objects to the theory which attributes to earthquakes a large share in the conformation of the globe, and points to remarkable cases from which, he says, "it would appear that although parts of the Earth's surface may be raised by the jar of an earthquake, like the lifting of the lid of a box, the truth, as it emerges, proves that this rise is only temporary, and the ground subsides again gradually into place when the shocks are over." I have referred to such phenomena as "the more demonstrative evidences of that vital action which is continually, though with great slowness, adding to the bulk of the Earth."

"Verifier" truly says that "The difficulties of modern Geology are greatly increased owing to its undertaking to produce vast effects with means which, on investigation, appear utterly inadequate to perform them. . . . To

overcome the resistance of a mountain mass, to lift the Alps or Andes, and at the same time to break them up into gorges and valleys, was assuredly due to no modified violence, no gentle taps renewed from time to time. In order to fully understand the magnitude of the work to be done by these gentle jogs, let us transport ourselves for a time into the midst of some of the grandest scenes of Nature's operations. Listen to the evidence of an unbiassed geological observer, possessing a minute knowledge of the highest mountain-chain, the Himalayas. 'The whole mass,' says Mr. Blandford, in a Report attached to the Geological Survey of India (p. 68), 'has been broken and disturbed, the rocks on one side of the fracture having been lifted up many thousands of feet, and crushed and crumpled together as the leaves of a book might be if placed edgeways between the boards of a powerful press. If we continue the section through the whole chain of the Himalaya, for some hundred miles, and still further into Thibet and the plain of the great Gobi, we should still find the same evidence of crushing and contortion. Here, then, is the work of a power compared to which the greatest of earthquakes sinks into insignificance. Since man began to record his experience of natural catastrophes no one has ever witnessed such gigantic movements of the crust of the Earth as here stand in existence.'"

"Verifier" observes that the advocates of modern causes account for the formation of mountains by some upheaving force acting from below, which idea underlies all their speculations. "Lyell," he says, "refers the elevation of mountain-chains to the effects of subterranean power, similar to that which causes volcanic eruptions; yet no one has satisfactorily ascertained the seat or origin of a power which, like that of the fabled giant of old, is to rise up under its mountain burthen. . . . Volcanoes are a purely collateral phenomena, which have existed in all ages of our planet. They are to it what boils and pustules are to the human body, a sort of safety-valve. Through holes in the Earth's crust they throw up cinder and lava heaps, veins, and dykes, after the manner of huge furnace chimneys, ejecting molten matter at their mouths or sides, which sometimes rises into permanent mountains and islands, but seldom effecting movement in the strata adjoining. In nine cases out of ten the outburst of trap and basalt has not raised the adjacent strata."

In opposition to Lyell, "Verifier" suggests that a *lateral* in place of a *vertical* movement has been the cause of the great natural operations which have given our Earth its

existing surface of hill and valley; such movement being "unconnected with 'causes now in action,' and in fact independent of them." He thinks that "the mountain masses of the globe, the basins of lakes, the channels of rivers, the deep bed of the ocean, its narrow straits and wide gulfs, are the result of overthrow, rather than upheaval, of fissures and cracks in Earth's surface caused by its contraction and shrinkage while the rocks were in the act of cooling down from the state of a molten mass, like a lava stream, solid above, yet resting on masses still pliant from heat, and movable below." The leading outline of this theory of a primeval split-up of the crust of the globe does not, says "Verifier," originate with him, many geologists—chiefly of the foreign schools—having approximated to it. It will be observed that, in speaking of volcanic phenomena, he uses a simile which is strictly applicable to a living or growing body; they are, he says, to the Earth what boils and pustules are to the human body. I find other writers indulging in language similarly suggestive of the truth of my view of creation. The idea that the Earth's loss of heat from radiation has performed an important part in the changes which have taken place on its surface has been, and still continues to be, a favourite one with a certain class of both astronomers and geologists. It is, however, discountenanced by Sir Charles Lyell in his "Principles." "When we consider," he says, "the discoveries recently made of the convertibility of one kind of force into another, and how light, heat, magnetism, electricity, and chemical affinity are intimately connected, we may well hesitate before we accept this theory of the constant diminution from age to age of a great source of dynamical and vital power." In reply to an "eminent physicist," who ridicules the search for some renovating power by which the amount of heat may be made to continue unimpaired for millions of years, as like the dreams of one who hopes to discover a source of perpetual motion, he answers—"But why should we despair of detecting proofs of such a regenerating and self-sustaining power in the works of a Divine Artificer? What is the origin of the force which governs the motions of the heavenly bodies? It has been likened to the intellectual power of the human will, which initiates and directs all our muscular actions. To define its nature has hitherto baffled the efforts of the metaphysician and natural philosopher, but assuredly we are not yet so far advanced in our knowledge of the system of the universe as to entitle us to declare that a great dynamical force like that of heat is on the wane."—Vol. i., p. 213, 10th ed.)

In suggesting that basins of lakes, channels of rivers, the deep bed of the ocean, &c., have been the result of contraction and shrinkage, while the rocks were "in the act of cooling down from the state of a molten mass," "Verifier" seems to overlook the fact that the character of the strata supposed to be thus affected entirely ignores the possibility of such a conclusion. Whatever may have been the condition of heat under which masses of granite have been produced, deposits of limestone, coal, and other analogous rocks, cannot have been formed when the globe was in the molten condition suggested. When limestone was deposited on the bed of the ocean, and coal was being formed by long successions of vegetable growth on dry land, the surface of the Earth cannot have differed essentially from its present condition. Such a degree of heat as that suggested would have converted the waters of the ocean into steam, and burnt up the vegetation of the dry land. Certainly the valleys and gorges at present existing cannot have been formed when the Earth was so hot that, as suggested by "Verifier," some of the "upper strata," like the waves in a moving lava stream, "would topple over and be absorbed in the glowing abyss below, to be re-melted into granite or trap." I could take him to a wide valley the sides of which consist, besides other stratified rocks, of several corresponding seams of coal lying at different elevations above the bed of the river. The banks slope up gently, the lower seam on each side being separated to the extent of about a quarter of a mile, while the seams above are divided to a much greater extent. Supposing that mere shrinkage from the radiation of heat could have produced such a degree of separation, which is very unlikely, the seams of coal must have experienced such a degree of heat at the time as would have burnt them up entirely and destroyed the present character of the other strata.

"Verifier" questions the assertion of geologists that considerable portions of the dry land are rising at the present time as the result of "tranquil movements of elevation and depression." He argues that, "while the fact itself is doubtful, Geology can furnish no reason why it should occur, which is a strong *prima facie* argument against it." He says that no light is thrown on the time or mode by which beds of sea-shells of existing species have been deposited at various heights considerably above the Baltic, and "we cannot suppose that Wales is at present emerging from the sea merely from the discovery of sea-shells on Moel Trivaen, which may have been placed there before the creation of man. The question we have to deal with is confined to

causes now in action, and we seek to ascertain what is going on at the present time."

I suggest that the difficulties thus described are overcome if, to the causes now in action, as enumerated by geologists, we add that of growth. "Verifier" is most successful in his criticism when he attacks "the theory of the erosive power of running water, and the conclusion that the valleys, gorges, and beds of rivers, many of them composed of the hardest and most indestructible of rocks, in all parts of the world, have been cut by the streams now running through them; however inconsiderable." He observes that, "the writers of the modern school of Geology adopt this as the basis of cosmical operations. Their system cannot work without it; it is laid down in their elementary manuals, and reasoned on in the profoundest of their philosophical papers, and those who dare to doubt are treated with ridicule. . . . Those who dwell near the rushing waters of cataracts are unconscious of the abrasion of a single foot or inch within the term of man's memory. The frequent growth of water-plants, mosses, sea-weeds, &c., on the very surface washed by rapid currents, ought also to create doubts as to the truth of this prevalent notion. Its general acceptance seems to be due to the confounding together of certain undoubted fluviatile operations. . . . Many of the great river-valleys display miles of lateral precipice, rising often to heights of 1000 and 2000 feet above the water, almost invariably as smooth and even as the walls of a house. No proof exists of any of the processes of watery action above enumerated being able to produce straight cliffs, *i.e.*, walls of rock." He further says that, "the Prussian engineers, at any rate, had no faith in such aid in 1833, when they had some trouble in removing, by means of gunpowder, the well-known reef stretching across the Rhine at Bingen, upon which so many barges had suffered wreck during hundreds of years, to the injury and opprobrium of Hanseatic commerce. Yet notwithstanding the full stream of the Rhine during so many ages had been unable to wear away this comparatively slight barrier, we are taught by geologists to believe that the long avenue of lofty precipices, including the Lurley, a little lower down, and consequently the whole of the gorge from Bingen to Neuwied, 60 miles long, have been cut through this same river Rhine."

I may here observe that Lyell does not attach such exclusive power to the erosion of running water. On the contrary, he complains that Hutton and Playfair ascribe valleys in general "too exclusively to the action of rivers

now flowing through them, not allowing sufficiently for the excavating and transporting power which the waves of the ocean exert on land during its emergence," and to "those inequalities of the surface which must be produced by movements accompanying the upheaval of the land." Lyell is, in fact, criticised by Colonel Greenwood, in "Rain and Rivers," more after the fashion of a warrior than a philosopher, because he attaches too little importance to the "perpetual disintegration, denudation, and destruction" which is produced by rain and rivers; the Colonel holding the reverse opinion to "Verifier."

In the volume already referred to, I have shown how improbable it is that the present bed of the St. Lawrence has been formed solely by water erosion (*see* "Constitution of the Earth," pp. 300 to 303). "Verifier" argues that the retrocession of Niagara Falls arises from the fact that the St. Lawrence flows over a bed of limestone 90 feet thick, between which lie soft shales of equal thickness; the splash of spray wafted up from below the Falls dissolves the soft shale, and the hard limestone breaks away by its own weight. But he overlooks the fact that Lyell, during a visit to the Falls, "obtained geological evidence of the former existence of an old river-bed," which he had no doubt indicated the original channel through which the waters once flowed from the Falls to Queenstown. Why did the St. Lawrence leave its ancient bed to form a chasm 90 feet deep, through the hard limestone? I have suggested that, under the actual circumstances, running water could produce no such effect, but that the change in its course must have been due to a disturbance of the crust of the Earth consequent upon internal expansion. "Verifier" in this instance abandons his theory that river-beds have originated in a primeval split-up of the crust of the globe consequent upon contraction and shrinkage whilst it was cooling down from a molten condition. It is clear that the fissure through which the St. Lawrence passes cannot have originated "in events, issues, and developments which have passed away," or "on a different condition of our planet from the present;" the ancient water-course showing that, long before the existence of the one down which the water now passes, the surface of the Earth did not differ greatly from its present condition.

"Verifier" refers most successfully to the great cataract of the Zambesi, in Central Africa, as an example, on the largest scale, of a river-bed made *for* the river and not *by* it. "This commanding stream having attained a width of more

than a mile, flowing along an undulatory plain bounded by distant hills, on a sudden drops down into a crack stretching directly across its course, forming a trough 350 feet deep, but not more than 80 feet wide, into which the whole body of water is discharged. The Fall is twice as high and twice as wide as Niagara, but differs from it in that, immediately opposite the Fall, rise three successive natural walls of rock of the same height as that over which the river leaps, separated from one another by narrow rifts. These triple barriers consist of wedge-shaped promontories of rock, with vertical sides, projecting alternately from the right bank and from the left, like side-scenes in a theatre, but entirely overlapping one another. Out of the first deep trough the river, after its descent, is compelled to find its way through a gap only 80 yards wide in the first opposing rock wall. A second wall here confronts it, by which the stream is turned at an acute angle to the right. It is next forced round the second promontory, then reversing its course round a third, and before it is allowed to escape to the sea it is compelled to double round a fourth wider headland."

"Verifier" forcibly argues that no action or application of running water could cause a river of first magnitude, flowing over a flat surface of rock, thus suddenly to drop into the bowels of the Earth. The surging river is obviously confined and governed in its course by the remarkable fissure through which it has to pass; but when "Verifier" suggests that the fissure was possibly the result of "some shrinkage of the basaltic rock, when cooling down from an incandescent state," he certainly does not offer a more probable origin than may be found in the known effects produced by earthquakes or the suggested results of subterranean movements. It is a favourite idea with some geologists and astronomers that certain phenomena are to be accounted for by the contraction or shrinkage of the Earth's crust consequent upon the radiation of heat; and yet the sedimentary rocks of which it is largely composed supply no evidence to justify the conclusion that in former ages they were subjected to a temperature greatly different from the present. Recent experiments, moreover, by Herren Nies and Winkelmann, show that the common idea as to the expansion of bodies by heat and their contraction on cooling (with the notable exception of ice) is erroneous. It has been found that silver, tin, zinc, iron, copper, bismuth, and antimony all expand when taking the solid form. The effect upon some of the other metals has not been clearly ascertained; but, as in the well-known case of ice, careful experiments justify the con-

clusion that the metals, as a rule, expand, and certainly do not contract, in solidifying.

Mountains in all parts of the world are split through to allow rivers to pass, observes "Verifier," and he instances the Litany, a river of Palestine, which if left to itself, according to the laws of Hydrostatics,—instead of cleaving the Lebanon to a depth of 600 feet, in places not more than 10 or 15 feet wide,—must have followed the lower opening presented to it, and passed into the Dead Sea. He asks, "Why should the Avon on quitting Bristol have altered its course, and, instead of running straightforward over the low ridge of Bedminster into the Bristol Channel, have turned north to encounter hills five times higher (400 to 500 feet), those of Leigh Downs, unless it had found the gorge of Clifton opened ready for it?" He argues that the gorge must have been produced by a "great convulsion," because the strata at one place has suffered a vertical displacement of 800 feet above those of the other. I would say that it has resulted from internal expansion consequent upon growth, and I can show him a precisely similar "convulsion," on a small scale, as the effect of growth upon the bark of a pear tree. The "upheaval" on one side of the crack, in the latter case, is indeed relatively much greater when the size of the trunk of the tree is compared with that of our globe. "Verifier" is more successful in suggesting that, when ravines have the strata on one side either lifted higher or sunk lower than those on the other, such phenomena cannot have been produced by the erosion of rivers, but are undeniably faults or fractures in the strata.

From the foregoing it will be evident that the author of "Scepticism in Geology" attaches much less importance than is usually assigned to denudation in connection with the present conformation of the surface of the Earth. His criticism, it may be objected, assumes an unwarranted degree of severity, especially when considered in connection with the rival theory which he propounds in substitution of "modern causes." "It is surely time," he exclaims, "that common sense should be exercised to resist the fallacy that weather, frost, ice, and running water (such as we now experience), could have carved out mountains, dug valleys, swept away piles of strata miles high, or strewed hills, valleys, and plains, all over the world, with streams of loose stones, including boulders as big as a house, gravel, clay, and earth. The reliance of modern Geology upon such feeble and inadequate agencies to produce such enormous results may perhaps be accounted for by the fact that a

teacher of this new philosophy assures us both that *time* is *power*, and that to attribute great effects to great causes is a prejudice." I have already suggested that time is simply an abstract conception of the changes which are continually going on in Nature. Time, in fact, represents the united forces (or the sum total of all the forces) of Nature. Whilst, therefore, time, apart from these forces, is a purely metaphysical idea, and can do nothing, as the representative of these forces it is omnipotent, having for its origin the Great Mover of the Universe. When we say that time will convert the sapling into a tree, we do not mean that the mere tick of the clock, or a number of rotations of the Earth upon its axis, will transform the sapling into a tree, but that certain forces or conditions, acting according to the order of God in Nature, will produce such a result. Take away the life of the sapling, and the rain and dew will fall, the sun will shine, and the air and soil will encompass it, all in vain.

Behind all the other forces recognised by geologists as having played important parts in producing the changes which have taken place on our globe, lies that of vital force, to which all the others are subservient. This is the force so sagaciously surmised by Lyell when he asks "What is the origin of the force which governs the motions of the heavenly bodies?" and which, he observes, "has been likened to the intellectual power of the human will, which initiates and directs all our muscular actions." Admit the presence of vital action in the form of growth, and all the conflicting theories to account for the changes which have taken place on the Earth's surface are reconciled. Electricity, magneticism, earthquakes, volcanoes, heat, and other "modes of motion," may be described as physiological processes due to or connected with vital action, whilst the fall of water, denudation, river erosion, sedimentary deposits, &c., are the mechanical effects; the whole being illustrative of "the unity of Nature." The slow expansion of the more plastic matter of the interior of the Earth has acted upon its crust like the growing tissue of a tree upon its bark. Cracks, and subsequently fissures, have thus been produced where the crust has been of a dry unyielding nature. These fissures have, in numerous cases, slowly widened, and become water-courses; and, where the material of the sides has been of a soft nature, it has, under suitable circumstances, been simultaneously corroded by the action of air and water, assisted by a changing temperature. The loose material thus produced, having been carried by successive

rains down the sides of the fissure, denudation has slowly assisted expansion in producing the slopes which are characteristic of the valley.

In some cases the expansive force has acted unequally upon the sides of a crack in the crust of the Earth, and one side has been "thrown up" higher than the other. Hence huge masses of strata are sometimes exposed, whilst the corresponding side of the crack can with difficulty be discovered. In other cases, where a similar effect has been produced, the upheaved side, having apparently been simultaneously with its slow elevation denuded by its exposure to air and water, cannot be distinguished on the surface. Upheavals, like the latter, are common in the North of England, and are sources of great trouble and expense in connection with coal-mining operations.

We have thus an explanation of the fact unexpectedly revealed by the *Challenger* Expedition, that the bottom of the deep ocean is not, as was commonly believed by geologists, covered by the sediment carried down by rivers, but by accumulations of the shells of microscopic animals which have lived at or near the surface. Denudation has not taken place to the extent that was supposed, nor has all the matter thus carried down the sides of gorges and valleys found its way into the ocean. A large portion of it has served to fill-up constantly widening cracks and fissures, or to form the slowly extending alluvium of valleys consequent upon the Earth's expansion.

In order, however, to understand more perfectly the changes which have taken place in the Earth's surface and its present state, we must imagine its condition before the era of water and sedimentary deposits; we must take lessons from the Moon and from our younger sister-planet, Venus. In an article which appeared in the "Journal of Science" for January, 1877, Mr. Edmund Neison, F.R.A.S., observes that, "many eminent physicists and geologists have recognised that the present condition of the surface of our satellite promises to throw much light on many vexed geological and physical problems. The opinion of that eminent geologist, Prof. Phillips, on the subject is well known, for he has often expressed his conviction that the lunar surface presented the best field for the study of many of the more difficult problems of Geology." Mr. Neison further says that, "It is a remarkable circumstance, in relation to the question, that whereas those astronomers who have devoted much time and labour to the study of the Moon's surface, and to whom astronomers in general are mainly indebted for

our present knowledge of the surface of our satellite, hold in general one view as to the present condition of the lunar surface, astronomers as a body hold a different opinion. To take a striking example: scarcely any astronomer known to have devoted time to the study of selenography doubts that many processes of actual lunar change are in progress, and it is doubtful if there is one who could not promptly instance one or more such cases. Yet the general opinion of astronomers appears to be against any such physical changes having occurred."

Extensive changes in the Moon suggest something of the nature of life, or vital action, and are therefore inconsistent with the mechanical view of the universe. Even scientists, though professing to be philosophers, do not easily believe disagreeable truths. More than twenty years ago, in a book entitled "The Earth we Inhabit," Captain Drayson showed that, whenever a base line had been measured a second time after a considerable lapse of years, the later measurements did not agree with the earlier, but were *greater* in every case. I am not aware that his statement has ever been contradicted, but astronomers still keep telling us that the Earth is *contracting!* Whenever the distance of the Earth from the Sun has been measured in connection with the transit of Venus, the latest measurement has always shown an increased distance between the two bodies; yet astronomers still insist that, instead of receding from, the Earth is *advancing* towards, the Sun! Mr. Neison need not, therefore, be surprised that astronomers refuse to recognise the facts which are vouched for by selenographers to establish the physical changes which are taking place in the Moon. I gather from his article that appearances have been discovered which suggest the probable existence of obscure processes of vegetation, but that its surface—which is in a more plastic, and therefore more changeable, condition than that of the Earth—consists largely of gloomy valleys (or "craters" and sterile mountains. The lesson is simple if my view of planetary creation is accepted. The Moon is an off-shoot of the Earth by natural processes still in operation, as the latter is an off-shoot of the Sun; and the Moon's present condition may be supposed to represent that of the Earth in the earliest stages of its history, when vegetation and sedimentary deposits, if any, had a very limited existence.

The planets Venus and Mercury, being nearer to the Sun, and therefore, according to my theory, correspondingly later in the order of creation than the Earth, will also illustrate its condition in remote ages. In consequence, however, of

their brightness, and being surrounded with atmospheres, we do not possess much information as to their surfaces; but it is believed that their mountains are relatively very much higher than those of the Earth, and it has been calculated that some exist in Venus between 20 and 30 miles high. If we could remove the waters of the ocean, and the sedimentary and other stratified deposits, the valleys of our globe would be some 6 miles deeper and the mountains correspondingly higher than at present. I believe that such inequalities are sufficient to account for the evidences of great heat and great cold in the earlier periods of geological history. The high or low degrees of temperature in any latitude is greatly a question of the depths of the valleys or the heights of the mountains, as demonstrated by the fact that, even in tropical regions, high mountains are perpetually covered with snow. It is not necessary, therefore, to imagine the existence of periods in which extreme heat or extreme cold alternately ruled upon the Earth. The great depths of the valleys and the great heights of the mountains in former ages will also help to explain the alternate depositions of coal, clay, gravel, sand, &c., which have taken place over the same areas. In such a condition of high mountain and deep valley in connection with the development of water, the deeper valleys would be liable, at intervals, to be overwhelmed by the breaking away of the waters of lakes or seas which existed at higher elevations. It has been supposed that, when the vegetation of the coal-measures was in the course of growth, the air was hotter and moister than at present. The presence of deep valleys in which such growth was favoured would account for such local condition of the atmosphere without the necessity for imagining a period of tropical heat over the entire globe. This greater contrast between valley and mountain would also account for the transport of large blocks of rock and other evidences of "glaciation" described by geologists. Curiously enough the belief in a "great ice age" is not unfrequently entertained in connection with the theory of radiation into space consequent upon the cooling-down of the Earth from a red-hot molten condition; as if such mechanical radiation had unaccountably stopped for a period and afterwards as unaccountably again commenced! With Immanuel Kant and Laplace I believe that the various substances of which the Earth is constituted once existed in a gaseous state, but with Lyell I see no reason to doubt that the forces by which the transformations have been made are the same in kind and degree as those which are now in operation.

IV. THE PHILOSOPHY OF PAIN.

By Frank Fernseed.

EVEN in these enlightened days the world is not content to ask what is, and how it is, but will persist in raising the much more difficult question, *why?* High authorities, leaders in methodology, from time to time rebuke us, pointing out that all such inquiries are not merely of doubtful solubility, but scarcely admit even of being scientifically stated. All this is in vain: mankind will persist in assuming the existence of a purpose in natural phenomena of the most varied orders, and in striving to trace out what that purpose may be. If, however, the subject I have ventured to take up is essentially illegitimate, I must crave the pardon of my readers for attempting to do what is done in thought even by those who turn away from it openly, as a mere waste of time and thought.

Pain has, next to its frequent companion, moral evil, ranked first among the shadows of the world we inhabit, until both, and much more, were summed up and comprehended under the modern name of the "struggle for existence." The question has again and again been raised, by saints and sages, as well as by every-day mortals, why a world in many respects so fair should be over-clouded with this almost omnipresent evil; why life can neither begin nor end except at the price of suffering? The answers have been various, satisfactory to their propounders, but rarely to the looker-on, least of all to the sufferer.

I remember a thinker, or perhaps dreamer, who maintained with great vehemence that pain was the normal and natural state of man, but that it only became an evil if we refused to accept it as our lot. I will not attempt to reproduce in English the somewhat misty arguments by which he strove to uphold his doctrine. Suffice it to say that he was nowise less eager to avoid this supposed natural condition than are other men, and that he was certainly not averse to any physical enjoyment.

There is a school of neo-stoics who take a view in some respects diametrically opposite. They contend that pain exists only in our own imaginations or in the feebleness of our will. Had we sufficient self-control pain would not merely be no longer an evil, but for us would cease to exist.

To criticise this theory is scarcely possible except we possessed the power of projecting our consciousness into the inner life of those who make this assertion. Possibly they may, from some constitutional peculiarity, have less sensitive nerves than their neighbours. Perhaps they may be able, by the mere force of will, to throw themselves into a state resembling catalepsy. We read of men who in the olden time were submitted to torture "for their souls' health," but who whilst on the rack seemed unconscious of what they were undergoing. But it seems to me that all immunity from pain due to such causes, as well as to delirium, drunkenness, violent passion, and the like, must be merely temporary. I have indeed known persons who had embraced, verbally at least, this stoical theory, found themselves yet unable to dispense with medical aid when suffering, *e.g.*, from tooth-ache or from neuralgia. It is therefore but fair to infer that what exceptional persons may possibly have once and again accomplished, in some state of exceptional excitement, signifies little for the mass of mankind. To them pain is a reality, to be dealt with by physical means only, and no more to be overcome by any psychic effort than are hunger and thirst.

The favourite theory concerning pain is due to the so-called "natural theologians." It views pain as a necessary evil, depending on the constitution of man and of the universe, and as being in its purpose benevolent. It is not a random, purposeless torment; still less is it punitive or vindictive. It is a self-acting natural contrivance for warning man—or rather animated nature altogether—against whatever might imperil the health or the life of the individual, and in consequence lessen the probability of the race or the species. Without its beneficent guidance we should rush to destruction.

These views were expounded with some wealth of illustration in a work which in its day was considered as heterodox enough, the "Constitution of Man," by G. Combe. They are adopted, with some slight transposition, by not a few Evolutionists, who, whilst denying purposiveness in the universe, seem to work round in an indirect manner to what is substantially the same thing.

Let us now examine this "warning" theory. It is the part of an efficient watchman to raise the alarm on the approach of any and every kind of danger; to let his warnings be proportionate in their urgency to the magnitude of the approaching mischief, not to raise a startling outcry if he espies a mouse entering the premises, and merely utter

a scarcely audible call if a fire is breaking out, or if a gang of burglars are picking the lock of the door. If worthy of the name he will also see to it that his danger-signal is not in itself an evil as great as, or perhaps greater than, the calamity to be warded off. He will not, *e.g.*, set fire to a corn-stack by way of making it known that a weasel has crept into the hen-roost. Above all, he will not keep silence till some mischief has been done, and summon the household after the enemy has made good his escape.

Let us examine in how far Pain, the self-acting watchman, answers to these very natural requirements. A man approaches his hand to a fire; he experiences the agreeable sensation of warmth. Encouraged by this he advances his hand nearer, and the feeling becomes slightly—perhaps very slightly—unpleasant. If he disregards the warning and approaches still nearer, he experiences decided pain, which grows more and more intense, till he reaches the climax of torture as he touches the glowing coals or allows the flame to play over his hand. If he still persists, the destruction of the member and grave peril to the entire system follow.

Here, therefore, the action of the "watchman" is, as far as we can perceive, perfect. An alarm is given at the very faintest approach of danger, and becomes gradually stronger and stronger as the peril increases. We must grant that if man, whether in consequence of specific creation or of evolution, were not unpleasantly affected by the near approach or actual contact of burning matter, he would be much more likely than at present to fall a sacrifice to the use of fire.

Again: I lay my hand quietly upon a hard substance—say a stone, or a bar of iron. I feel resistance, but nothing to be called pain. I repeat the experiment, bringing down my hand upon the object with some appreciable force. I at once experience pain, the more severe the heavier has been the blow. If I disregard the warning, or if I have no sense of pain and thus cannot perceive it, and if I strike still more violently, the hand may be bruised or shattered. The case is quite similar whenever we come in contact with any hard, rough, or sharp object. In all these cases the warning is in its nature perfect, never-failing, and strictly proportionate to the exigency. We never feel more pain from the gentle touch of a hard object than from the violent blow. If we were deprived of this susceptibility to pain we should not be gainers, but losers. It is highly probable that, should a race of men or an animal species spring up who were not unpleasantly affected by contact with fire, with bodies which can cut, pierce, or lacerate, their chances of survival and

multiplication would, in accordance with the doctrine of Natural Selection, be decidedly small.

But we must not stop here. How is the case with internal diseases of the human system? In all affections of the inflammatory class pain is an essential and substantially never-failing feature. The sufferer is duly warned that something is amiss with him, and may at any rate seek means for relief. Here, too, it may safely be contended that the severity and acuteness of the torment is fairly proportionate to the urgency of the danger; and it must also be at once granted that if acute disease of the vitals were unattended with pain, and were consequently liable to be overlooked, the change would not be beneficial either to the individual or the species.

Now, however, we meet with facts of a totally different class. There are not a few diseases of the most serious character where nothing like pain is ever experienced, and where the sufferer consequently goes on in his usual course, totally unaware of any danger, till he falls down dead, or is at least completely prostrated. Everyone must have met with the statement—stereotyped we might almost call it, in cases of apoplexy—that "the deceased was apparently in the enjoyment of perfect health." Surely a disease indicator which does not act in affections of the brain and the heart is very far from perfect. It might be contended that in these very diseases a warning might be more beneficial than in acute affections. In the latter the alarm is often, in fact, too late, unless efficient medical aid is at once procurable. But if a man were made aware by any signals that morbid changes were in progress in his heart or in his brain, he might modify his way of living and avoid whatever is likely to foster the disease. It is not too much to say that many a person might prolong his life by merely avoiding excitement, if he were only warned of the necessity of thus acting. But here, where the danger is extreme, and where a caution might save, the "watchman" makes no sign! Pain, therefore, is not a general warning against all physical perils, even the most urgent. Just as conscience in case of moral diseases, so pain in bodily derangement is merely a partial and irregular monitor.

We may pass now to an example almost diametrically opposite in its character. The decay, and even the ultimate loss, of a tooth is of but little moment. Yet few pains are so violent, so prolonged, so utterly distracting as tooth-ache—the warning which the "watchman" employs to inform us that there is something wrong with one of our grinders. For so slight a cause a man may for months be deprived of

due sleep, be hindered in taking food, and to a great extent incapacitated for his business. In this case we find almost all the characteristics of the efficient watchman either absent, or it might even be said reversed. The alarm, especially if we compare this case with the painless approach of apoplexy, is inversely as the danger. The warning given is in itself a far greater evil than the mischief to be warded off. The result, moreover, is in the majority of cases not the preservation, but the loss of the part affected. Thus all the suffering experienced practically goes for nothing. It can scarcely be contended that man gains anything by the extreme sensitiveness which the nerves of the teeth possess. Should a variety of the human race spring up in whom these nerves became insensible on the first approach of decay in the teeth, such a race would, *pro tanto*, fare not worse, but better, in the struggle for existence.

I have, in accordance with a very generally-received opinion, pronounced the sensitiveness of man to the contact of external objects a safeguard against a variety of dangers. But even here there are certain limits easily and often exceeded, beyond which this sensitiveness, so far from being an advantage to its possessors, becomes a serious drawback. It is well known that in all those parts of the world—tropical, temperate, or arctic—where mosquitoes, sandflies, &c., are numerous, they form a very tangible obstacle in the way of man's "replenishing and subduing" the world. It is also on record that sensitiveness to the bites of these and similar vermin varies greatly in different persons. Whilst some experience merely a very slight irritation, which quickly passes off, the bites in others occasion swellings and inflammation of a very annoying character. I know of cases where the attacks of the common English midge have rendered medical treatment necessary. On the other hand, I enjoy immunity from the bite of *Simulium columbaczense*, one of the most dreaded of these tiny marauders. Seeing, therefore, how greatly human susceptibility to gnat-bites can vary, it is at least conceivable that a strain of our species might some time arise who would experience no annoyance from such insects. It is beyond all dispute that in many parts of the world such a race would, *cæteris paribus*, possess a decided advantage over ordinary mortals, and would have a natural tendency to preponderate in all regions infested with mosquitoes. Extreme sensitiveness to heat, to cold, to wind, &c., is also no safeguard or advantage, but a decided element of weakness.

Hence we see that the susceptibility to pain in animals,

and especially in man, is of a very complex character in its results,—not always good, nor always evil; sometimes a friend, and sometimes useless, if not hostile.

Such being the facts, we may well pause before pronouncing it a principle divinely implanted for our preservation, or, viewing the case from another side, before concluding that it has played a fundamental and favourable part in human development.

There are those who assert that pain is merely an intensification of feelings which in their normal degree are pleasurable. This view holds good perhaps alone in the case of temperature, where a certain range not differing greatly from the heat of our own bodies is pleasant, but becomes more and more painful, and even deadly, as it rises above or sinks below this standard. But this heat-sensation is perfectly exceptional and unique in thus changing its character in accordance with its degree. The gentlest contact with rock or iron bar, with the point of a thorn or the edge of a knife, is certainly not painful, but as certainly not pleasant. Or take the sensations of acute disease; they are no intensification of any ordinary normal state. When in perfect health we are simply unconscious of the very existence of those organs which when diseased become the seat of intense torment. There is no transit from pleasure to pain, for those parts are never the seat of pleasure. Two points must here indeed be noted—the greater intensity of pain as compared with pleasure, and the far wider scope which the former possesses in the animal body. What physical delight can be for a moment likened in its height to the pangs of tooth-ache? There is no part, internal or external, which may not become the seat of pain, whilst how few are ever, or can ever become, the seat of any positive pleasure!

But this last word reminds us of a new difficulty. If pain is a warning mark or consequence, attached to certain actions that we may carefully avoid them, and if the growing violence of pain—as in the case of putting our finger in the fire—is an evidence of growing danger, we might not unnaturally expect that pleasure would be a characteristic mark of whatever is safe and salutary—the more salutary the more intense the delight.

But how does this conclusion agree with experience? Have we no foods delicious to the taste, but of doubtful digestibility or wholesomeness, sometimes even positively poisonous? Have we no beverages, of pleasant flavour and aroma, but which some authorities condemn altogether, whilst others declare them dangerous, except used with

great caution? Have we no climates, exhilirating, soothing, balmy, but where the air is laden at once with perfume and pestilence? Do not our moralists universally bid us beware of pleasure? Is it not, then, strange that the two opposites, pain and pleasure, should both be signals of danger or marks of what must be approached with caution? What can here be the hidden purpose? It seems to me that no philosophy of pain can be constituted unless it is able to solve this capital difficulty—a difficulty equally formidable to the advocate of special creation and to the evolutionist. But in the meantime there is nothing in the warning or beneficent theory of pain which can command our full assent. It explains certain cases in a satisfactory manner, but it breaks down in others.

The last theory of pain that I shall mention is one now almost abandoned, though for centuries it met with general recognition. It regards bodily suffering not as an original and essential feature of the universe, but as a consequence of moral evil. How deeply this notion is, or at least was, rooted in the human mind is apparent from the history of language. Philologians tell us that the very word "pain" means originally "penalty" or "punishment." I shall perhaps be voted old-fashioned for even adverting to such a theory. But it seems to me that if pain has in it anything of purpose, and has been ordained by a conscious Intelligence, the phenomena of the case agree better with this view than with any other.

V. THE WEIGHTS AND MEASURES QUESTION RECONSIDERED.

By An Old Technologist.

SURELY all rational controversy between the old and the metric systems of weights and measures is by this time over. The last word surely has been said, and there remains for the upholders of our present standards merely a dogged determination to cling to things as they are, or at the best a hesitation in face of the great inconvenience

which a change would bring to the present generation, and to the sacrifice of the not inconsiderable capital invested in weights and in measures of length and capacity!

Such is a very fair specimen of the language used by advocates of the metric system. Such is the language I have myself formerly used, for I have in my day been the duly appointed "Hon. Sec." to a certain local committee for the introduction of the metric system into the United Kingdom. As the said committee, after electing its officers, never again could be got to meet, I am not very gravely committed to the movement.

But setting such mere personal considerations on one side, let us see whether in this case all is really gold that glitters, —whether such truly scientific men as the late Sir John Herschell, in opposing the projected reform, were actuated by no better feeling than what we, for want of a more appropriate name, term "mere conservatism."

I will begin with some very ample concessions. I will at once grant that two scales of weight, like the Troy and the Avoirdupoise, bearing no definite or simple relation to each other, are not to be defended. I will admit, as evils, that we have two linear measures, the one for length in the abstract, and the other for what it is now the fashion to call "textile" goods; that our measures for superficial extent, *e.g.*, land, are not simply the squares of either of the above, and that our measures of capacity are not the same for liquids and for solids, and that neither of them is correlated with our standards of length. Foreigners ask us occasionally, not unjustifiably, how any rational beings can tolerate a system of measures where the unit of a higher denomination is not the product of the lower by a whole number, as in the case where 16½ feet make 1 statute pole. To do away with these inconsistencies would be something more than a mere sacrifice to our love for logical symmetry and consequence—if, indeed, we Englishmen have any such feeling, and not rather its opposite. We are told to think what the metric system offers us in the way of tangible convenience and saving of labour. It sets out with the metre, originally, but—as it has since been discovered—erroneously, supposed to be the ten-millionth part of the length of a meridian from the Pole to the Equator. From this one basis the whole system of measures and weights flows as a connected whole. Square the metre and its multiples, and we have the measures of surface, no matter to what they are applied. Cube the metre, and we have the standard of capacity for liquids or solids. Fill such a cube with distilled water, and weigh it,

and we get the unit of weight. It is plain that the introduction of such a system would do away at a stroke with the so-called "compound" rules of arithmetic, and with the "tables" so laboriously instilled into children—a consideration of no small weight in these days of School-Boardism. It would, beyond all doubt, greatly reduce the amount of work in commercial houses.

I have heard it maintained, by highly competent judges, that were a decimal system of weights, measures, and money introduced, our great bankers, merchants, and manufacturers might dispense with one clerk out of every five. It is, further, beyond a doubt that the adoption of the metric standard would much facilitate all transactions with the countries where it is already established, *i.e.*, all Europe, except Turkey and Russia.

But the great question remains, how would it act in retail trade in those transactions which, though individually small, come home to every one in the routine of daily life? Here I must confess that there are some features of the metric system, not necessarily involved in its two fundamental principles, which I look upon with distrust, as likely to work badly in the hands of the great body of the people. If we look at our traditional system of weights and measures we find that their names are short,—with few exceptions monosyllabic,—inch, foot, yard, mile; grain, drachm, ounce, pound, ton; gill, pint, quart, &c. Now if we glance down a table of metric weights and measures we find different grades expressed by words of three, four, or even five syllables. Some of these names, too, are annoyingly like each other, and liable to be confounded together, as decimetre and decametre, decilitre and decalitre, decigramme and decagramme. The fact is that the French commissioners made a great mistake in selecting "classical" names for their weights and measures, which they considered might be adopted by other nations without translation.

Further, the numbers used in our system as factors and divisors are mostly small, and easily dealt with in the mind. Two, four, six, eight, or ten ounces of anything are magnitudes easily remembered. Nor, if we know the price of a pound, is it difficult to reckon mentally what is the price of each of these quantities. But suppose we take their approximate metric equivalents, 58, 116, 174, 232, or 290 grammes: here are numbers much less readily carried in the memory.

In calculating the price, too, there is the same or a greater difficulty. If 1 lb. of "coffee as in France" costs a shilling,

there are few children old enough to go on an errand who cannot calculate the price of 4 or 8 ounces. But if asked if 1 kilo. of any article costs a franc, what should be paid for 116 or 290 grammes? many of us—not children, nor exceptionally ignorant—would feel somewhat puzzled. The metric system in its present form brings us in contact with numbers beyond the reach of the multiplication table, and we consequently require the aid of paper and pencil to cast up the results. The fact is this system, as at present organised, is not decimal, but centesimal or millesimal. One thousand grms. make 1 kilo., the two intervening denominations (the decagrm. = 10 grms., and the hectogrm. = 100 grms. or 10 decagrms.) being practically never used. The same holds good of the measures of capacity, the decalitre or hectolitre. I can safely say that in the thousands of French, Belgian, and German receipts for dyeing, printing, or colour-making which have come under my notice, I have never seen any denomination of weight between the gramme and the kilo., or any denomination of measure of capacity above the litre.

It is just the same with money in the countries of the "Latin Union." Between the franc and its hundredth part, the centime, there is no intervening denomination.

Further, in our old traditional English system we can express very small quantities, weights, or measures, by whole numbers. A grain, a grain-measure, a line, are quantities below which it is rarely necessary to go, save in refined scientific investigations, in the manufacture of instruments of precision, &c. For the purposes of daily life and for retail trade nothing smaller is wanted; but in the metric system the smallest magnitudes which are expressed in integers are much larger, and that in a mutually disproportionate degree. The smallest weight written as a whole number is the gramme = 15·438 grains; the smallest measure of capacity is the litre = 1·76 pints; and the smallest measure of length is the metre = 39·37 inches. Here, surely, is inconvenience and inconsistence,—the less to be tolerated as occurring in a system which takes its stand upon strict consistency!

It may be contended that these high values for the lowest denomination are not a disadvantage. I reject such contention. The higher is fixed the smallest denomination expressed in whole numbers, the sooner we are driven into the realm of fractions,—decimal fractions, as a matter of course. Now such fractions, however convenient to deal with, pen or pencil in hand, are most perplexing for mental calculation. Except we possess exceptional arithmetical powers,

we forget where to put the decimal point, and of course get bewildered!

It may be said that centesimal and millesimal reckoning becomes easy to the great mass of the public with practice. Experience does not prove this to be the case. A writer, whose name we forget, has pointed out—what any traveller in France may verify for himself—that when the process of ticket-giving begins at a French railway-station, an official takes his stand at the window to tell the booking-clerk within and the passenger without what two and a half return tickets at 1 franc 65 centimes come to. French money would be much easier added up if, instead of two columns only for francs and centimes, there were three, for francs, tenths of francs (which I may provisionally call pence), and centimes.

Again, it is a remarkable fact that in all the countries which have adopted the metric system, vulgar fractions, though denounced as heterodox, creep in. Who has not heard, in the shop of a French grocer, &c., customers asking for a "mi-kilo." of sugar or coffee? Indeed, in some countries which have adopted the metric system, this "mi-kilo." (= about 17 ounces) figures as a metric pound. In receipts and formulæ of all kinds I very frequently find such quantities as the quarter, the third, and even the thirty-second, of a litre specified.

Sir John Herschel maintained, not without grounds, that successive halving is an instinctive propensity of man, and that consequently any system which discards halves, quarters, and eighths must be regarded as unnatural. Of this we have a very good instance in the 112, 56, 28, 14, 7, and $3\frac{1}{2}$ lb. weights used in warehouses and shops, and it is said that some tradesmen have even memorialised the authorities to allow the use of a $1\frac{3}{4}$ lb. weight!

The nomenclature and the notation of the metric system seem to me to want reorganising. It requires plain, short, simple names for its various grades, to be expressed in such a manner as to banish the decimal point beyond all ordinary transactions. It needs, too, terms for the half, the fourth, &c., of its chief denominations. The various names, so long as they express one and the same thing, need not be identical in different languages. If we call the 17 oz. weight pound in English, livre in French, lira in Italian, and pfund in German, any one of these terms is surely more convenient than 500 grammes.

It has been said that the universal adoption of the metric system would facilitate business. But it should not be forgotten that, in consequence of the development of

protectionist principles, our business with the metric countries is not likely to increase, and it may become at least an open question whether under these circumstances such facilitation of business may not be in certain cases undesirable.

There is one department in which a step in advance might be taken by the supercession of all systems of weights, and the adoption simply of "parts." In all receipts, prescriptions, or formulæ of every kind, such "parts" should be the sole standard, everything being expressed by weight. Every person using the formula would refer these "parts" to his own standards, whether these were grains or grammes, pounds or kilos. In this manner all fractions are avoided. I fear that the spread of the metric system has acted unfavourably upon this simplest of all methods.

There is another way of drawing up receipts common in America, and exceedingly simple. The ingredients to be used are expressed as a percentage on the substance to be operated upon. Thus, suppose it is desired to dye 100 lbs. wool a cochineal scarlet, the receipt directs us to take so much per cent of cochineal, oxalic acid, chloride of tin, flavine, &c. It strikes me that the percentage system might be extended to medicine. Physiologists find in their researches that a drug becomes poisonous, or exhibits some lower degree of activity, when it bears such or such a proportion to the entire weight of the animal to which it is administered. Perhaps it will be found that the weight of a sick person furnishes the scale of the doses of medicine which may be usefully given.

For strictly scientific purposes I fail to see that the gramme, the litre, and their multiples and sub-multiples, have any advantage over the grain and the grain-measure.

The introduction of the metric system into retail trade, especially without the re-organisation I sketched out, would prove not merely inconvenient, but positively injurious to the great body of the nation, especially to the working-classes, since certain "pushing" tradesmen would not fail to utilise the new and imperfectly-known weights and measures as a basis for imposition.

There is a further consideration:—Hitherto we have been utterly unable to enforce unity of weights and measures on the old system. A peck of potatoes, apples, &c., is 20 lbs in Lancashire, 21 lbs. in Sheffield, 14 lbs. in Huddersfield and 16 lbs. in Halifax. A stone of anything is in some districts 14, and in others 16 lbs. The gill is in the North of England half a pint, but in the South only a quarter.

Almost every county has its peculiar acre, and in some parts land is measured by "day's works."

Not further to multiply examples, it would seem, judging from these facts, that to introduce a new system of weights and measures into general and exclusive use would require an amount of official interference and espionage which the nation would be apt to resent.

ANALYSES OF BOOKS.

The New Truth and the Old Faith. By A SCIENTIFIC LAYMAN. London: C. Kegan Paul and Co.

THE conflict, real or supposed, between modern science on the one hand and religion on the other, seems to be gaining increased importance. We have able writers who seek to reconcile these two great powers; we have others who are zealously striving to widen the breach. This latter tendency is much to be deplored, whether it appears in *savant* or ecclesiastic. We must never forget that Science is in a state of rapid change,—that many of her theories are merely tentative, and contain much that, however probable, is far from being actually and conclusively demonstrated. On the other hand, our interpreters of Revelation are not altogether guiltless of the charge of clinging to the letter rather than to the spirit. They forget the grand principle laid down by Galileo, that the Scriptures are not a geological, biological, or physical revelation, but that on all such questions they convey, for the most part, the ideas of the ages when they were written. It seems to us that if we possess our souls in patience we may see some of the ominous discrepancies and apparent contradictions vanish away. We doubt whether, in this country at least, those who are foremost in real scientific work are anxious to "banish God from this our universe." That part is played rather by men who hover about the battle-fields of Science somewhat like Hotspur's fop on the plain of Holmedon, and who earn reputation by utilising the brains of others.

The author of the work before us is evidently a man of Science, and no less evidently a Theist and a Christian, and he comes forward with the laudable object of harmonising, if possible, the "conflicting ideas which are floating in the minds of the younger generation," or at least showing distinctly what are the points at issue. To this grave task he brings an evident love for truth, and an amount of learning which it would be idle to disparage. He accepts, provisionally at least, Evolution, but like ourselves* he regards it as God's way of creation, and as by no means irreconcilable with the existence of design in the Universe.

The work opens with an Introduction, in which the results of modern research are clearly summarised. He notices, without criticising, the strange theory of Prof. Helmholtz and Sir W. Thomson, that the first germs of life may have been brought to

* May we not say like Darwin and Lamarck?

our earth on a meteoric stone from other realms of space. But how did it originate in those other realms?

The definition which the author gives of species we are unable to accept, since the existence of fertile hybrids is now placed beyond all doubt. The body of the work is an answer to the three great questions, Whence, What, and Whither? He asks, "What is the mysterious tendency to minor variations from the special type in individual animals,—what but the inherent and God-given propensity of the organism to strike out a new form or to adjust itself to its environment?" Certainly we are not able to account for this tendency to vary, unless implanted in the organism; and by whom implanted? It has been shown repeatedly, in the "Journal of Science" as well as elsewhere, that Natural Selection must have incipient variations to work upon. It has even been asked whether the "struggle for existence" does not tend rather to reduce than to increase the number of species? Wo find in this connection a statement which we feel bound to reject:—"Until man appeared, all animal life was guided by instinct." There are few working naturalists who do not admit the rationality of the lower animals, though of course on a very limited scale.

On p. 87 we find the remark:—"The newly-introduced flora fed on the inorganic world, and purified the foul atmosphere; while a fauna came after to feed, in its turn, on the vegetation, and breathe the purer air." This passage seems scarcely in harmony with what we read on p. 34:—"Geology shows that although vegetation developed more rapidly than animal life, they progressed together." But throughout this first section we must pronounce the author's general line of argument as, in our judgment, sound. We feel little difficulty in endorsing the words in which he sums up this part of his considerations:—

"Evolution leads us to take an infinitely grander, though more visionary, view of the universe than Genesis reveals. Instead of a series of separate pictures, it presents us with a continuous panorama of creation. It shows us Nature as an intimate union of beauty and fitness, a pageant to the sense, a mechanism to the intellect; and in striving to survey this mighty plan the imagination seems to get a glimpse of the sublime truth that Cosmos realises the poetic dream, the transitory Art of God."

The two succeeding sections, "What?" and "Whither?" contain much into which we cannot legitimately enter in these pages, and not a few passages upon which we must beg to differ from "A Scientific Layman." Thus he writes—"By far the greater portion (of the earth) is made up of six of these, namely, oxygen, hydrogen, nitrogen, carbon, sulphur, and phosphorus." Sodium, calcium, aluminium, silicium are certainly present in far larger proportions than phosphorus if not than sulphur also. Nor can we assent to the statement that animals contain no cellulose (*see* Schœrer, "Ann. Chem. Pharm.," clx., 312).

The hypothesis advanced by some recent writers, that all matter is in some sense alive, the author pronounces "the wildest notion that ever emanated from a bewildered materialist." The probability of man "giving place to a superior animal evolved from him grows," he thinks, "very small." The following reflection is happy:—"God did not make the world beautiful that we might enjoy it, but rather He constructed us so that we could see and appreciate the beauty of the world."

Passing over the chapter on Free Will as scarcely within our competence, we come to the consideration of Evil.

Our author finds himself unable to accept literally the "biblical account of the Fall," which he considers "inconsistent with the development theory." It would seem, however, to some of our friends that the world gives actual indications of a great change for the worse, of which glaciation was perhaps the most striking manifestation. The expulsion of man from his original garden home, the use of "skins of beasts" for clothing, and the adoption of an animal diet, all seem to point to a permanent deterioration of climate. But however this may be, the account of the Fall is either a history of facts or an apologue. If the latter, it can have but one root—the necessity felt by early thinkers for some means of reconciling the vast amount of evil existing in the world with the supremacy of a wise and benevolent God.

"A Scientific Layman," without adopting the extreme creed of the Optimist School, seems to us rather to under-estimate the amount of suffering in the world. When saying "Death, if sharp, is a short event," he scarcely gives due weight to the fact that multitudes of animals perish yearly from the sheer want of food. We have not clear evidence that there is "keen pleasure in the excitement of the very strife which animals wage." Such pleasure will assuredly not be felt by the mother-bird vainly striving to defend her nestlings against rats, weasels, or snakes. It will have scant room in the frog chased by a cobra, or in the antelope seized by a tiger. We must also bear in mind that the struggle for existence, as between species, is far from leading to the survival of the most useful and the most beautiful. The species, animal or vegetable, that gain ground in the world appear to be mainly vermin and weeds.

In the chapter on God we read:—"It would certainly seem as if the Divine Architect had aimed at magnitude rather than perfection, and the good of the greatest number rather than the good of all. It would seem that His great problem was the utilisation of energy for the support of immense multitudes of successive beings in a state of partial happiness." This view differs after all but little from that which the author quotes from the "Journal of Science," viz., that if a maximum of earthly enjoyment and the minimisation of earthly suffering had been the objects of the Creator, the world would assuredly have been constituted very different from what it is.

The chapters on Prayer, Immortality, Revelation, Christ, the Old Creed, and the New Evangels, though of profound interest, lie outside of our legitimate scope.

In the conclusion the author brings forward certain wholesome cautions, too often overlooked. He reminds us that Science cannot deny the spiritual efficacy of Prayer, and cannot demonstrate that there is no Hereafter. He bids us consider that the process of Evolution is not at all fully understood, and that even the theory of the conservation of energy is only "a daring inference drawn from our present scientific experience."

The "New Truth and the Old Faith" is a work well deserving thoughtful perusal, and may be advantageously studied even by the many who will not accept the author's conclusions.

The Causes which Produce the Great Prevailing Winds and Ocean Currents, and their Effects on Climate. By C. A. M. TABER. Boston: D. Clapp and Son.

THIS small pamphlet deals with most important questions, and supplies matter for grave reflection. In his speculations on glaciation, the author remarks that the Antarctic ice-cap is constantly increasing in diameter, and will probably continue so to do till it closes the channel connecting the Atlantic and Pacific south of Cape Horn. Glaciers have already appeared in the Southern Andes, and with a fall of temperature will rapidly cover Patagonia and Chili, and push out to sea, uniting with the southern ice-cap.

The author criticises the theories of Lyell and of Dr. Croll, and finds himself unable to accept them. He points out that ice is gradually increasing round the Poles in both hemispheres. The northern regions are being chilled because the Arctic currents are constantly forcing the waters of the Gulf Stream southwards. All the climatic agents now operating in northern latitude furnish all the conditions requisite for the slow but constant increase of cold, and consequently for the introduction of a new Glacial epoch. In support of this view he cites facts of common notoriety. The oceans of the temperate zone have become more boisterous than in the days of the early navigators. Greenland was found by the Northmen clothed with verdure in parts now covered with enormous glaciers. Iceland has retrograded in fertility. In France the culture of the vine is admitted by Arago to be receding southwards. The past three winters in Britain have been of exceptional severity, and our summers have been now for several years most pitiful. Even the most effeminate writers in our comic and "society" papers can now scarcely

pretend to suffer from heat in July and August. In Norway the past winter is said to have been more severe than has been experienced for many years.

If such a change is really going on, agricultural depression in Britain and Ireland, with all its consequences direct and indirect, must continue to increase in spite alike of legislation and agitation. Civilisation in Europe will gradually have to retire, and those nations which have secured territories in tropical or subtropical regions will be compelled to take refuge there. The narrowed expanse of habitable and cultivable lands will necessitate a wolfish struggle for existence, in which the weak and the scrupulous must perish. The only fact we can remember which does not agree with the author's prediction of an approaching ice-age is the decrease of the glaciers of the Alps.

We must recommend this little work not merely to men of science, but to all who can see or who care to look beyond the exigencies of the present moment.

Sight: an Exposition of the Principles of Monocular and Binocular Vision. By Joseph Le Conte, LL.D., Professor of Geology and Natural History in the University of California. London: C. Kegan Paul and Co.

Prof. Le Conte will be doubtless favourably known to most of our readers as an able and thoughtful naturalist, but they will be perhaps some little surprised to find him taking up a subject which is generally left to the physicists. He contends, however, that there is not in the English language any work covering the same ground as that which he has selected, and he pronounces, not without truth, the study of vision almost exceptional as a means of scientific culture, connecting together, as it does, the sciences of physics, physiology, and even psychology.

In an introductory section the author treats of the relation of general sensibility to special sense. He deals with the gradation among the senses. In touch we require direct and generally solid contact; in taste, liquid contact; in smell, aëriform contact; in hearing contact is no longer needed, and we perceive at a distance; lastly, in sight, we recognise objects at a distance which is illimitable. He remarks that it is on these two higher senses that Fine Art is wholly, and Science is mainly, founded. Here we must suggest a doubt. We have often imagined it possible to constitute a fine art appealing to the sense of smell, and in chemistry both smell and taste give us much more information concerning the properties of bodies than does hearing. Prof. Le Conte confines himself, in the book before us, to human sight,

and he considers, in succession, monocular vision, binocular vision, and some disputed points in the latter.

As regards the defects of the eye now so frequently met with, he points out an error in the popular notion of presbyopy, the so-called long-sightedness of old age. Such an eye sees distant objects precisely as does the normal eye. Its focus of parallel rays is not behind, but on the retina. There has not taken place any flattening, but the power to adjust for near objects has been lost. Short-sightedness is a structural defect which does not disappear with advancing age; presbyopy is a functional disorder. The true opposite to myopy (short-sightedness) is the unusual defect of hypermetropy. Persons in this state, even when young, see near objects imperfectly; when old they fail to see either distant or remote objects with clearnesss, and require two kinds of glasses—one for near, and one for distant objects.

We find a notice of Stanley Hall's recent theory of colour-perception. He argues that colour is perceived by the cones alone, that different parts of the same cone vibrate with different degrees of rapidity, and that the conical form is adapted for this purpose. In an occasional reference to instinct we are glad to find so eminent and well-tried an observer declare it to be "inherited experience."

A peculiarity of the work before us is that the author pronounces the normal eye a master-piece of Nature, and infinitely superior to the microscope. Certain modern writers take a decidedly different view, and pronounce it not nearly so good as the objectives of our best microscopes. There is here scope for a not uninteresting discussion.

In the last chapter we find the comparative physiology of binocular vision regarded as a gift bestowed upon the highest animals only, and not impossibly connected with the development of the higher faculties of the mind.

One feature of this book strikes us as in need of explanation. Though printed in London, we find in it those peculiarities in orthography which have been adopted in the United States. The Americans have, of course, the right to spell as they please, but we surely may put in a similar claim, and must protest against having "fiber" and "center" insinuated into a book published in England, and to be read by Englishmen.

Note-Book of an Amateur Geologist. By JOHN EDWARD LEE, F.G.S., F.S.A. London: Longmans and Co.

THIS work consists of a large assortment of plates executed from the sketches made by the author in the course of his geological and archæological rambles, and of accompanying descriptions.

Hence, though containing much valuable matter, it is a difficult subject for the critic.

Mr. Lee is one of the founders of the British Association, and was the intimate friend and companion of the late Prof. Phillips. As such he has taken no small part in the progress of geology. Hence interesting anecdotes crop up unexpectedly among the descriptive matter. It appears that he had once agreed with Prof. Phillips—then President of the Geological Society—to undertake a thorough examination of the strata underlying the chalk in Lincolnshire. "The reader may imagine my surprise when, the day after one of the meetings in London, Prof. Phillips wrote a characteristic little note, of little more than half-a-dozen lines, saying that at the meeting an unknown young man, of the name of Judd, read an excellent paper on the Lincolnshire beds, and that consequently our work was done, as he had worked it far better than we should have done it. Our excursion was given up, and the unknown young man is now Professor Judd."

In 1842-3 the author experienced a peculiar misfortune. In the former year he had forwarded to the "Annals and Magazine of Natural History" a paper on some Dermal Plates of Saurian Character from the Wealden of the Isle of Wight. A drawing accompanied the paper, and a correspondence ensued with one of the editors, who said that if the scale were sent up to his care a careful drawing of it should be made for the plate. This was done, but month after month passed over without the insertion of the paper, and it was not till some time after that the editor expressed his great regret that the paper, the drawings, and the specimen itself, had been lost in a public conveyance on the way to the lithographer! The almost unique specimen was never recovered. Fortunately a rough drawing had previously been sent to Mr. Charlesworth, a copy of which and of the paper are here inserted.

When on the Riffelberg, in Switzerland, the author made an observation which confirms the popular assertion that some local cause renders the indications of the compass incorrect.

The bulk of the work, however, as we have already intimated, is intelligible only if taken in conjunction with the illustrations.

As a frontispiece we find the skull of a "cave-bear" (*Ursus spelæus*), which the author obtained from the celebrated bone-cavern of Ojcow, near Cracow. The length of the specimen is between 20 and 21 inches.

On the Geology of Florida. By EUGENE A. SMITH, of the University of Alabama. (Reprinted from the "American Journal of Science.")

FROM this interesting memoir we extract the author's chief conclusions:—Until the end of the Eocene period this region was still submerged. During the Middle and Upper Tertiary epochs the peninsula was much broader than at present, the coast-line extending from 100 to 150 miles farther to the westward. After the Miocene period there was again an elevation of Florida, followed, during the Champlain period, by submergence. Afterwards came a re-elevation, which brought up the peninsula with approximately its present configuration.

Proceedings of the Bristol Naturalists' Society. New Series, Vol. III., Part 1. 1879. Bristol: Kerslake and Co.

WE are always exceedingly happy to find our provincial scientific societies active and prosperous: the Bristol Naturalists' Society may be congratulated on its position in both respects. It is doing a fair amount of work, and its financial position is satisfactory. The principal memoirs in the number before us are—"Some new Optical Illusions," by Prof. Sylvanus P. Thompson; "Underground Temperature," by E. Wethered; the "Structure and Life-History of a Sponge," by W. G. Sollas (a very suggestive paper); Cases of Prolification in *Cyclamen Persicum*," by Adolph Leipner; the "Ethnology of the Hindoo Koosh," by Dr. J. Beddoe; a "Catalogue of the Lepidoptera of the Bristol District," by A. E. Hudd; the "Fungi of the Bristol District," by C. Bucknall; and the "Pomarine Skua," by H. Chartonnier.

Owing to the dismal character of the season (1879) the excursions of the geological and entomological sections proved failures. The botanical section was also much checked in its field-work. It is, however, making good progress with a most important task—the preparation of a Flora of the Bristol Coalfields.

It may perhaps seem captious if we, after all, declare that we are not quite content with the Society. A total of 169 members is scarcely all that can be desired in so populous, wealthy, and intelligent a city! We must hope that the future will bring improvement in this respect. We must congratulate the Society in being free from that disturbing element, a literary section.

A Monograph of the Silurian Fossils of the Girvan District in Ayrshire, with Special Reference to those contained in the "Gray Collection." By H. ALLEYNE NICHOLSON, M.D., D.Sc., &c. Fasciculus III. Edinburgh and London: W. Blackwood and Sons.

THIS portion of Dr. Nicholson's work is devoted to the Annelids and Echinodermata, with Supplements on the Protozoa, Cœlenterata, and Crustacea, and contains descriptions of the genera *Clathrodictyon*, *Hyalonema*. *Heliolites*, *Plasmopora*, *Propora*, *Pinacopora*, *Halysites*, and *Favosites*. The Supplements refer to the Crustacean order Trilobita, to the Thoracica (Cirripedia), and to certain Annelida. Here the author examines the so-called worm-tracks of the Girvan District, a kind of organic remains explained by some authorities as the trails of wandering Annelides, by others as tracks made by Mollusca or Crustacea, while others ascribe to them a vegetable origin.

The illustrations to the work are of a very satisfactory character.

Records of the Geological Survey of India. Vol. XIV., Part 1. 1881.

FROM the annual report it appears that Mr. Griesbach has attempted to correlate the rocks of Peninsular India with those of the Himalayas and of the world beyond the seas.

It is proposed to establish an office of mining records in Bengal.

M. Lydekker, in a Report on the Geology of Dardistan and Baltistan, notices the size of its glaciers in the present day. That at Biafo is probably next to the Humboldt glacier of Greenland, the largest in the world. The present lower limit of glaciation is about 10,000 feet above the sea-level. The Palma glacier is pronounced to be decidedly increasing, though at one time it may have united with that of Biafo. The author concludes that the glaciers of the Himalaya were once of vastly greater extent than at present, but that there is no evidence of a continuous ice-cap over the summits of the mountains. He considers that the glaciation of Europe and the Himalayas was contemporaneous, and that the degree of cold experienced must have been far greater than at present.

M. Lydekker likewise furnishes a valuable Report on some Siwalik Carnivora.

On the Structure and Affinities of the Genus Monticulipora *and its Subgenera, with Critical Descriptions of Illustrative Species.* By H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E., F.L.S. Edinburgh and London: W. Blackwood and Sons.

Prof. Nicholson steadily continues his laborious researches in palæozoology, turning his attention mainly to marine forms of life. He disclaims for the present work the title of a monograph, as it does not even exhaust his own collection of Monticuliporoids. He complains, and with perfect right, of the difficulty of identifying many, even typical, species. When using a name we are not certain of really dealing with the form so named by the original founder of the species. Hence an immense amount of work remains to be done before palæozoology has definite materials to work upon, and the determination of stratigraphical horizons by means of their characteristic fossils is—especially as far as the palæozoic deposits are concerned—rendered very untrustworthy. Hence the object of the work is to define and characterise forms which have been insufficiently described. The illustrations have been chiefly drawn by the author himself, and, in all but three or four instances, from specimens and slides in his own collection.

Dr. Nicholson defines the genus *Monticulipora*, in its widest sense, as "including forms in which the corallum is composed of numerous closely approximated tubular corallites, the walls of which are never absolutely amalgamated with one another, though sometimes apparently so. Walls ofthe corallites imperforate; septa entirely wanting; tabulæ always present in greater or less number, though sometimes obsolete; generally 'complete,' and approximately horizontal, but sometimes incomplete. The corallites are sometimes divisible into two distinct groups, one of large and the other of small tubes, the latter usually more closely tabulate than the large tubes. The surface often shows, at regular intervals, areas raised above the general level of the surface 'monticules,' or slightly depressed, and then known as maculæ." The author then examines the modifications of this general outline as exhibited in the subdivisions of the genus. He shows that the nature and disposition of the corallites are not sufficient for a basis of natural classification.

On the development of the group he is unable to agree with the conclusions of Dr. Lindstroem. As regards the affinities and zoological position of the group, he considers that there is no real relationship at all between *Heteropora* and *Monticulipora*. He then reviews the relation of the genus to the extinct forms *Chæteles*, *Stenopora*, *Tetradium*, *Ceramopora*, and *Heterodictya*, and proceeds to a consideration of the subgenera and the species.

The book, even to naturalists who have no specific acquaintance with the group in question or its allies, presents undoubted evidence of sterling work.

Text-Book of Systematic Mineralogy. By HILARY BAUERMAN, F.G.S. London: Longmans and Co.

THIS treatise is a worthy member of Messrs. Longmans' valuable series of "Text-Books of Science," and will be of great use to those students—not too numerous—who are engaged with mineralogy as distinct from geology, on the one hand, and from chemistry on the other.

The author characterises minerals as inorganic natural species, to be distinguished from each other by considerations of form, structure, and composition. The determination of the first of these points, *i.e.*, crystallography, may be pronounced a purely geometrical question. The author points out the law, established by observation, though not explained, that all save the simpler types of symmetry about an axis, *i.e.*, the binary, the quaternary, ternary, and senary, are wanting. Pentagonal symmetry, so common in the organic world, is here wanting.

In the crystallographic part of the work Mr. Bauerman adopts a mixed system of notation, designating the forms by their symbols according to Naumann, and noting their faces by the indices of Miller's system.

We are glad to find the optical properties of crystals dealt with in a reasonably full and satisfactory manner. These characters are becoming daily of more importance in the diagnosis of mineral species,—and we may add of chemical compounds,—organic or inorganic. It is therefore very satisfactory to know that there exists an accessible work of moderate compass to which the student may be referred. The phenomena of double refraction, of uniaxial and circular and biaxial polarisation, interference figures, rhombic and oblique dispersion, are clearly described.

After due notice of the thermic and electric properties of minerals the author passes on to their chemical examination, in which he adopts the system of Rammelsberg.

Descriptive mineralogy is reserved for a future volume. The work is one which may be unhesitatingly recommended.

A Preface to, with Extracts from, a Book of the Beginnings. By GERALD MASSEY. London: Williams and Norgate.

WE have here specimens of a work which, if the author's contentions can be maintained, is likely to effect a grave modification in anthropology, not to speak of philology, mythology, and other studies more remote from our ordinary subjects. Hence we venture to say that it deserves a calm and serious examination at the hands of competent judges. To make of such a book a mere peg upon which to hang jests far from "sage-born" is a mistake much to be regretted.

Mr. Massey holds that Inner Africa—some region to the south of Egypt—is the cradle of civilisation and of language, and not Chaldæa, India, China, or the highlands of Central Asia, He considers that the Sanscrit and Prakrit languages are comparatively modern. The "Aryan hypothesis," or, as one of his correspondents terms it, the "Indo-Germanic nuisance," he sets aside. He treats sun-worship, and consequently the solar myth, as posterior to moon-worship and star-worship. He goes farther back than the "roots" from which Prof. Max Müller and his school seek to derive language. Now we make no claims to authority as a philologian, but when weighing in the balance, and finding wanting, Prof. Müller's alleged distinction between man and the lower animals, we felt compelled to say that it would be necessary to go much farther back than he has done. The most intimate knowledge of the composition, flow, and quantity of the water of the Thames and its tributaries does not enable us to dogmatise on the vapours from which such waters have been condensed, or on the currents which have wafted them hither. When Prof. Max Müller, in his reply to Prof. Huxley's laudation of the new Birmingham College, sought—on the "nothing like leather" principle—to argue that things could not be rightly studied without a previous training in words, we, who hold that there is nothing in words beyond what their generally ignorant framers put into them, could only sigh at the illusion. We felt convinced that words would yet be thrust down to their true level as the mere "counters of wise men." It seems to us that Mr. Massey is operating in this direction. He writes—"Such supposed roots as Pâ, Tâ, and Mâ, in Sanscrit are not roots at all, *i.e.*, not primary, but reduced forms of earlier words found with their ideographic determinatives in the hieroglyphics, and with the roots vanishes the rootage." "The thing we most need to know at present is not what was the 'inward mental phase' that corresponded to the so-called 'roots' as the germs of human speech, but what are the outward and visible types by which the early men represented their thoughts to the best of their ability." "The types in which the earlier thinkers *thinged*

their thoughts are recoverable." Thing and think! The connection is suggestive.

Concerning the validity of Mr. Massey's speculations we can form no decisive opinion from the mere fragments of his work before us. The criticism which we should suggest would first and foremost involve an inquiry how far the origin of mankind and of civilisation in Africa agree with known facts and laws, geological and biological. We may provisionally declare that equatorial Africa is a very likely place for the origin of mankind, and here, accordingly, geological research should be pressed forward.

We salute Mr. Massey as a fellow Evolutionist, though knowing nothing of him save what we glean from these pages, and we trust his views will meet with that impartial scrutiny which, we are sure, is all he demands.

Bulletin of the United States Geological and Geographical Survey of the Territories. Vol. VI., No. 1. Washington: Government Printing-Office.

THIS volume contains the report of Prof. Asa Gray and Sir J. D Hooker on the Vegetation of the Rocky Mountains, in comparison with that of other parts of the world. This elaborate and celebrated document has already been widely circulated in England, and accordingly gives little scope for comment. Many readers must have been no little surprised at the richness of the Japan Manchurian forest flora, which in number of species so far exceeds that of the Atlantic American forest, not to speak of the far poorer forests of Europe and of the Pacific Slopes of North America. These features of distribution are shown to depend not on present conditions of the climates, but on their meteorological history. "Vegetable archæology," as Prof. Gray terms it, is a new and promising field for botanical research.

That able and indefatigable palæontologist Dr. E. D. Cope has furnished memoirs on certain new Batrachia and Reptilia from the Permian beds of Texas; on a Wading Bird from the Amyzon Shales; on the Nimravidæ and Canidæ of the Miocene; and on the Vertebrata of the Wind River Eocene Beds of Wyoming. The Nimravidæ are a group composed of seven, or perhaps eight, extinct genera, which the author separates from the true cats as having the carotid and condylar foramina entirely distinct from the foramen lacerum posterius, and as having, further, an alisphenoid canal and post-glenoid and post-parietal foramina, which are wanting in the Felidæ. He suggests that the Oxyœnidæ may have been the ancestors both of the Felidæ and Nimravidæ, though several intervening forms are missing

Certain of the Nimravidæ appear to have been large and formidable.

Amongst the species obtained from the Wind River Eocenes a prominent place belongs to *Protopsalis tigrinus*, belonging probably to the Oxyœnidæ. It was an animal apparently equalling the tiger in size.

A Complete Course of Problems in Practical Plane Geometry, with an Introduction to Elementary Solid Geometry. New Edition, Revised and Enlarged. By JOHN WILLIAM PALLISER. London: Simpkin and Marshall.

THE author, after pointing out the importance of geometry for art-students and artizans of every kind, tells us that in his practical experience as a teacher—in connection, more especially, with the Leeds School of Art and Science, and with the Science and Art Classes of the Leeds Young Men's Christian Association—he has been unable to meet with a text-book at once sufficiently cheap and comprehensive for his students. He found that both teachers and pupils were obliged to obtain and consult a number of works on geometry in order to prepare for the examinations of the Science and Art Department. To do away with the consequent expenditure of time and money he has issued the work before us. Now although we do not believe in examinations, and consider that preparing for these performances is a radically false starting-point in any science whatsoever, we consider that the manual before us is likely to be very useful. It is characterised by clearness, simplicity, and a sound arrangement, and will, we think, fully meet the exigencies of the case.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

THE EARTH'S TEMPERATURE.

To the Editor of the Journal of Science.

HYPOTHESIS: The heat of the earth is caused by pressure.

SIR,—Although not aware of it, I am probably not the first to attribute the temperature of the Earth—or rather the increasing heat thereof—to pressure, or, in other words, to maintain that the weight of the material above becomes converted into heat below,—its only escape; and, on inquiry into the matter, this theory seems amply borne out by fact: moreover, I am encouraged to lay this view before the world, because on mentioning it to an authority in these matters he did not see reason to reject it, but was not prepared to express an opinion.

It is almost certainly demonstrated that, after reaching the depth of about 50 feet below the surface, the temperature regularly increases at the rate of 1° F. for about every interval of 60 yards. Thus, if it can be proved that the pressure of a layer of rock would produce the same rate of increase, it is very plausible to infer that this is the cause: this can, I believe, be satisfactorily shown.

Dr. Joules's statistics of the conversion of mechanical energy into heat are, I think, the best to go by. He demonstrates conclusively that if a weight of 1 lb. fall 772 feet, it will raise the temperature of 1 lb. of water 1° F. His experiment, of course, cannot be applied to earth, yet the latter is a material like the former, and is under the same laws. Will not the same pressure on a pound of water produce the same amount of heat as on an equal amount of earth? Now the foot-pounds to raise a cubic foot of water 1° F. are 48·250; but directly we turn to minerals we are at once met with a host of differences in weight. Taking Molesworth's Tables we find 150 lbs. per cubic foot about a fair average. Practically a column of rock $12'' \times 12'' = 1$ lb., or a cubic foot 144 lbs. (Mr. A. Lupton, Yorkshire College), perhaps rather more. At the end of the first depth of 60 feet, for 1° F.,

we reach the depth of 330 feet (50 + 60 yards). Multiply 330 × 144 = 47,720, a figure which, all sides considered, is identical with Dr. Joules's, and from a perfectly different source.

May we not say, then, that the *actual* state of the heat of earth agrees with the theoretical hypothesis and Dr. Joules's experiments, and that *the heat is due to the pressure.* No one denies that pressure does produce heat; even so light a thing as air is found to be heated by compression with its own weight at the bottom of a pit's shaft; and air, if compressed strongly enough, will ignite tinder, as most people know,—then why not earth?

It may be argued that this would uphold the theory of the fluidity of the earth's interior, but seemingly we are as much in the dark as ever. For if we consider the earth as made up of so many concentric hollow spheres, fitting one inside another, we can see that the weight, or gravity, is really concentrated in the inner side of the globe, and, being circular every way, is self-supporting; so much so that the imaginary resultants will not pass beyond the inner surface centreward, and therefore there will be little, if any, downward thrust. It is evident, also, that there would be a greater weight, side thrusting, &c., in the outer sphere than in any of the inner ones; hence the heat would actually decrease (from this cause) towards the earth's centre: there must be a limit to compression; we cannot press material that cannot escape anywhere into nothing. Moreover, if the world were a mass of fluid in an egg-shell, would not its magnetic influence be destroyed, &c.? We must always look at these things with a large, comprehensive view; even in our deepest mine we have not even pierced this egg-shell in proportion, and therefore can draw no indisputable conclusion.

And finally, why are volcanoes always at the top of mountains? The volcanoes came to the mountains, and not the mountains to the volcanoes. This rises many interesting questions which are best left till we see whether this stands.—I am, &c.,

DAVID YEWDALL CLIFF.

Ilkley, Leeds, May 10, 1881.

THE FORMATIVE POWER IN NATURE.

To the Editor of the Journal of Science.

SIR,—Had it been my intention to criticise the article on "The Formative Power in Nature" in any adverse spirit, I should have affixed my name in full to the letter in your No. for April. But my comments on Mr. Billing's article were far from being in opposition to his views, and were designed rather to supplement

and support, than to controvert his arguments. I thought, and still think, that we are both on the same side in the contest between Theistic and Atheistic Philosophy, which so sadly divides modern scientists. I have no doubt, however, that he will pardon my making a few remarks upon certain observations in his second article, touching my letter.

1. Allow me to say that I did *not* suppose that he aimed at *originality*, seeing that the subject was one that scarcely admitted of it.

2. I fully agree with his severe, but well-merited remarks upon the wild and often absurd theories propounded by some (so-called) philosophers, both ancient and modern.

3. Haeckel on Spontaneity. I am quite aware of the definition Prof. H. gives of spontaneous or equivocal generation, as well as the ordinary sense of *spontaneous*, as applied to the feelings or actions of men or animals, when not controlled or influenced by any extraneous will. But I must still maintain, that to talk of that which has yet *no existence* as exerting *will* (*sponte*), to give itself existence, is absolutely contradictory. I do not indeed imagine that anything we can say (hard or not) would weigh one feather with these self-sufficient Monists; but that is no reason why we should abstain from exposing their fallacies, to the best of our ability, for the benefit of "casual readers and half-thinking men."

4. The Ether. We apparently differ slightly as to the nature of this medium, which *must* needs be to a great extent conjectural: Mr. B. considering it (p. 82) as "a gaseous substance," from the solidification of which "solid substances" (not stratifications, as first written) have arisen; or (p. 272) the "one primordial substance from the modification and differentiation of which all other forms of matter have arisen"; while I prefer to regard it as a permanent form of matter, but one *sui generis*. Let the two notions go for what they are worth. But looking to Mr. B.'s original words and their explanation, I cannot see that I was guilty of "raising a phantom assumption." I fully agree, however, that the Ether is "a subtle something which permeates the universe, and which proceeds direct from the will of the Creator, in which all things exist."

One word as to the epithet *luminiferous* (so wofully mangled in the printing). It was doubtless conferred upon the ether, because, as its existence was first revealed by *light*, so it *brings*, or is the vehicle of, light. Paradoxical as it may appear to ordinary apprehension, neither light nor heat, as such, have an *objective* existence at all. They are only rates of vibratory motion, translated into subjective sensations in the nervous system by the correlative powers of the living mind.

Mr. Billing (p. 273) implies that I consider the ether to be the *source* of light (a term I did not use), and objects that, if it were so, the higher we get in the air "the brighter should be the aspect," while balloonists find it both darker and colder. To this

I answer, that the general light of the sky, which becomes less and less as the atmosphere becomes rarer, is the result of the reflecting properties of its molecules, whether gaseous or aqueous. And were a human eye placed beyond the atmosphere every part would appear absolutely black, except the spaces occupied by the sun and other celestial bodies, whose brightness would be almost insupportable. In the same way *sensible heat* depends much less upon the direct rays of the sun than upon the secondary vibrations set up in the denser media by which we are here surrounded: it is only in *part* due to the direct heat-rays of the sun.

To my own mind the conviction appears irresistible, that not only does the ether "proceed direct from the will of the Creator," but that all its wondrous motions are nothing else and nothing less than the constant, regular, and orderly acting of the same Will, using it as its main instrument throughout the universe. And as I seem to be challenged (p. 276) to say what I conceive *force* to be, I do not hesitate to define it as the acting of the will of a living mind (either original or created), and that all physical forces which are not the result of created minds, are necessarily the outcome on the Supreme Mind and Will.

I must not trespass further upon your space than to add, that my name, unabbreviated, will be found at the head of the first article in your *Journal* of last January.—I am, &c.,

H. B.

A FIRST CAUSE.

To the Editor of the Journal of Science.

Sir,—I submit that the following is a reply to the letter of "A Lucretian," on p. 304 of last No. of your Journal. Dr. Büchner says "a force can only exist in as far as it is active;" this is quite right. Newton says of it "*consistit in actione solâ.*" But, using "force" in its correct technical sense, it is clearly wrong to speak of the first cause of the world as a *force*. If we can give it any name derived from dynamics, we should call it an *energy*. But an energy does not depend on activity for existence. The very title of Dr. Büchner's well-known book, "Matter and Force," taken in connection with its object, is enough to show that he uses "force" (*kraft*) in a vague unscientific manner, and that he is open to the complaint made by Clifford against numerous writers on the subject of Force (*see* "Nature," June 10, 1880).—I am, &c.,

M. H. C.

SANITARY CONDITIONS.

To the Editor of the Journal of Science.

SIR,—A medical contemporary of yours remarks it as something anomalous that the Boers of the Transvaal should be hale and vigorous whilst living under very imperfect sanitary regulations. The writer seems to forget that these men are at any rate free from the most important of all causes of debility, *i.e.*, worry and over-work.

The men who first enticed women and children into an industrial career, and they who have in later times devised the scheme of competitive examination, have done more to enfeeble the British race than can be counterbalanced by the most perfect systems of drainage and ventilation, with the highest personal cleanliness superadded.—I am, &c.,

G. O. H.

AN ALLEGED CONTRAST BETWEEN MAN AND BRUTES.

To the Editor of the Journal of Science.

SIR,—In his essays on the "Unity of Nature" the Duke of Argyll seeks to point out an anomaly in the moral conduct of man as contrasted with that of the lower animals. He mentions especially three points in which man differs unfavourably from the lower animals, viz., his propensity to infanticide, to cannibalism, and to ill-usage of the weaker sex. It seems to me, however, that the distinction is by no means absolute. Among several species of rodents—*e.g.*, the rabbit—the female hides her young from the male, and has occasionally to defend them against his attacks. The same thing occurs among the Felidæ. The sow and the female cat will occasionally kill and eat their own offspring, and that not from want of food or lack of shelter. Male alligators greedily devour the young of their own species. The eagerness of the queen bee to put to death her female progeny is well known.

Cannibalism is likewise not unknown among brutes. Rats, if shut up together, fight, and the weaker ones are devoured. Wolves eat up a wounded comrade without mercy. A stronger

spider is always ready to kill and eat a weaker individual, even of the same species.

Nor is the weaker sex always treated with kindness by the stronger. The domestic cock sometimes takes a dislike to a particular hen, and in such cases he beats, and even kills her. An ill-tempered bull has been known to gore a cow. Among American deer the male has been observed tyrannising over the female. Prof. Semper relates a similar case concerning a pair of prairie-dogs which he keeps in his house. Among spiders, where the female is the stronger, the male often serves as a nuptial banquet for his spouse.

Hence there is not in this respect that absolute contrast which the noble author seems to assume.—I am, &c.,

SCRUTATOR.

NOTES.

MR. CHARLES DARWIN has expressed his ideas upon vivisection in a letter to Prof. Holmgren. He writes:—"I know that Physiology cannot possibly progress except by means of experiments on living animals, and I feel the deepest conviction that he who retards the progress of Physiology commits a crime against mankind. Anyone who remembers, as I can, the state of this science half a century ago must admit that it has made immense progress, and it is now progressing at an ever-increasing rate. What improvements in medical practice may be directly attributed to physiological research is a question which can be properly discussed only by those physiologists and medical practitioners who have studied the history of these subjects; but, so far as I can learn, the benefits are already very great. No one, unless he is grossly ignorant of what Science has done for mankind, can entertain any doubt of the incalculable benefits which will hereafter be derived from Physiology, not only by man, but by the lower animals."

"The vivisectionists," says Mr. E. M. Boddy, "protest with well-feigned horror at a frog or a rabbit, under the influence of chloroform being experimented upon for the benefit of humanity, whilst they see, without allowing a sign of disapprobation to escape them, an inoffensive hare chased to death for the amusement of gentility."

P. Grawitz has experimentally refuted both the current hypotheses on the protective action of vaccinations, in the generalised sense of the term. He shows that blood from rabbits which had been inoculated with Aspergillus, if mixed with a further dose of the spores, developed a luxuriant crop of fungus. Hence the blood had neither been exhausted of any pabulum, nor had any antidote been developed in it.—*Virchow's Archiv. für Path. Anatomie.*

According to papers communicated to the Bristol Naturalists' Society, by Dr. Beddoes, F.R.S., and Mr. F. F. Tuckett, the size of the human head in this country has been gradually diminishing during the last twenty-five years. The evidence on which these authors base their conclusion is obtained from hatters in various parts of England and Scotland. One hatter writes:—"Fifteen years ago the usual sizes of hats in England were from $6\frac{1}{4}$ to $7\frac{3}{8}$, and even $7\frac{1}{2}$ was not uncommon, but now if a $7\frac{3}{8}$ hat was wanted we should have to make a block purposely." *Quære*, has a similar decrease been observed in France, Germany, and the United States?

Dr. R. W. Shufeldt ("American Naturalist") points out that comparatively few birds are free from disease or the sequelæ of disease, and gives some interesting cases from his own observation.

In the same journal A. S. Packard, jun., gives a very valuable description of the brain of the locust as compared with the same part in other insects.

The same writer agrees with Prof. Carl Vogt in holding that different continents may have simultaneously produced representatives or similar species, and that we should not accept a single centre of creation for all faunas.

A writer in the "American Naturalist" strongly insists upon the value of the wren as a destroyer of noxious insects.

Prof. S. A. Forbes, of the Illinois State Laboratory of Natural History, in the same journal, argues that a species injurious to man can never be exterminated by a parasite strictly dependent upon it.

According to the "Medical Press and Circular" an "anomalous febrile disorder" has appeared in Aberdeen in the present month. In all the cases the patients had obtained a supply of milk from one particular dairy farm in the neighbourhood. But the cows there were healthy, and the water-supply unimpeachable. The turnips given to the animals were suspected, but nothing definite has transpired. Were the cows fed on sewage-grown turnips or hay?

Edgar L. Larkin, in "Science," argues that if the gaseous matter originally filling the universe was, as supposed by many authors, a "glowing vapour" or a "fire mist," the law of the 'correlation of force' or the 'conservation of energy' must fall to ruin.

According to the same journal Dr. A. F. A. King read a paper on "Septennial Periodicity" in the Organic World, before the Biological Society of Washington. The learned author drew attention to the phenomena of menstruation, œstration in animals, gestation, contagion, epidemics, and climax of fevers.

M. de Quatrefages, in certain laudatory remarks on the "Leçons d'Anatomie et de Physiologie Comparées" of Prof. Milne-Edwards, pronounced it a work which would be for a long time for all students what Haller's great work was formerly! Those who remember how disastrous the influence of Haller proved for biological science will not regard this comparison as a high compliment.

The perch in the Seine are at present suffering from an epidemic attack of a parasite.

According to M. H. Filhol ("Comptes Rendus") the fossil remains of *Ursus spelæus* possess a great fixity of type, and show no connection with the modern *U. arctos*. A skull of the latter species, of an enormous size, has been found among about a hundred specimens of *U. spelæus* in the Cave of Lherm, in the Department of Arriège.

It appears that the writers of the Talmud held and taught the globular shape of the earth. This is the more interesting since at this moment bills are being circulated denouncing existing astronomical truths as of heathenish origin, and urging the formation of a society to advocate the flatness and fixity of the earth.

W. von Reichenau, in a recent work on the nests and eggs of birds, explains the ornamental plumage, crests, &c., of the male sex as due to an excess of vital energy, whilst the females are comparatively exhausted by the production of eggs and the task of incubation.

According to MM. Klebs and Crudeli ("Att. Dei Lincei," Sec. 3, vol. v., p. 19) the malarial parasites (*Bacilli*) pass through a series of phases corresponding to the successive stages of the disease.

According to a series of careful experiments performed by Dr. C. A. Cameron ("Analyst"), the milk of individual cows may contain less than 9 per cent of solids *minus* fat. But in mixed milk 9 per cent is a fair proportion to expect. The milk of Dublin dairy herds contains 13 to 15 per cent of solids.

The views of Mr. Larkin and Mr. Morris on the evolution of matter and of the heavenly bodies are being criticised ("Science," April 16) by Prof. Al. Wincheil.

Mr. A. D. Bartlett points out a curious distinction between carnivorous and herbivorous animals. The former, if caught young and kindly treated, become much attached to their keepers. On the other hand, stags, antelopes, sheep, &c., if brought up as household pets, invariably turn out dangerous.

The Mosaic prohibition of blood as an article of diet, whatever may be its origin, is in full accord with the dictates of the most advanced science of modern times.

Mr. J. W. Norris, the Superintendent of the United States Yellowstone National Park, has issued a most interesting report on the geological and biological features of this wonderful region.

Prof. Asaph Hall ("Science") pronounces the Nebular Hypothesis a very doubtful thing, though "possibly its supporters may fudge it so that it will last a little longer."

We learn that Mr. G. Benn, of Glenravel House, Co. Antrim, has presented the valuable collection of antiquities formed by his brother, the late Mr. E. Benn, to the Belfast Museum.

S. A. Forbes, of Normal, Illinois, having shot and opened twenty-five sparrows, found that at a season when 30 per cent of the food of the robin, 20 per cent of that of the cat-bird, and 90 per cent of that of the blue bird, consisted of insects, the stomachs of the sparrows did not contain more than 6 per cent of insects.

The muster-roll of the Royal Commission on the Medical Acts will excite astonishment in foreign countries. It comprises the Earl of Camperdown, the Bishop of Peterborough, Sir G. Jessel, Mr. Sclater-Booth, Mr. W. Cohen, Prof. Bryce, Sir W. Jenner, Prof. Huxley, Mr. Simon, Prof. Turner, and Dr. R. McDonnel. Only four medical men!

Dr. Dowse, in his work "The Brain and Diseases of the Nervous System," says "Brain exhaustion from over-study and so-called cramming is perhaps one of the greatest social evils of modern times, and is simply a blot upon advancing civilisation.'

According to M. Voitellier, rabies in dogs is more common in the male sex than in the female, in the proportion of 100 to 14.

A Microscopical Society is about to be established at Carlisle.

The "Monthly Magazine of Pharmacy," in reviewing Prof. St. George Mivart's recent work "The Cat," remarks—"However much we may differ from him (the author) in his Darwinian proclivities, and certain other of his philosophical opinions," &c. We should think anyone reading Mr. Mivart's "Lessons from Nature" would pronounce his proclivities decidedly anti-Darwinian.

M. Turpin has laid before the French Academy of Medicine a series of 1440 pigments, suitable for children's toys, and all of them free from poisonous matter.

According to the "American Journal of Microscopy," red blood corpuscules were detected in eleven out of twenty specimens of vaccine lymph.

We were misinformed when we stated that Dr. Beale's late Presidential Address would not be printed. It appears in full in the "Journal of the Royal Microscopical Society."

H. H. Howarth, in his paper on the Mammoth in Europe ("Geological Magazine"), points out that the terms Europe and Asia are purely artificial, and correspond to nothing in physical geography. Between the two there is no botanical or zoological barrier.

Mr. W. G. Lock ("Geological Magazine") suggests the possibility of a mass of molten matter underlying Europe, and connected with the Icelandic volcanic vents.

A sea-side biological laboratory will be opened at Annisquam, Mass., on June 5th, under the auspices of the Boston Society of Natural History and the Woman's Education Association.

"Science" considers that the immunity from a second attack of an infectious disease, such as poultry-cholera, is simply inexplicable on the parasitic theory.

The "American Naturalist" suggests a joint meeting of the British and the American Associations for the Advancement of Science, to be held in 1883. The idea seems to us excellent, but we fear it will meet with much passive, if not active, opposition.

It appears that during the severe weather of January rooks were found killing and eating sparrows, and even the blackbirds began to prey upon each other.

According to Grawitz ("American Naturalist") the mould Eurotium and Aspergillus possess forms which produce death within a few days if they penetrate into the circulatory system of animals.

"Blackwood's Magazine" points out that the revival of suicide coincides in time with the modern spread of education, and is most rampant where the schoolmaster is most active.

A young Russian lady, who was studying Medicine in Paris, shot herself in despair of passing her examination.

A case of fasting is in progress in Strathaven. A girl there has for eighteen weeks taken nothing but water, and occasionally sweets.

A curious friendship between two young cats and a cockatoo has come under our notice. The cats, after having completed their own toilet, generally wash the bird in the most approved manner.

Dr. Alleyne Nicholson will conduct the Natural History Class at Edinburgh University, in consequence of the indisposition of Prof. Sir Wyville Thompson.

The "Medical Press and Circular," of May 11th, admits, in a leading article, the impotence of "sanitary reform" to deal with epidemics.

At the Saratoga meeting of the American Pharmaceutical Association it was shown, in the Presidential Address, that among the evil consequences of a reckless devastation of the forests, the extirpation of certain valuable medicinal plants must not be forgotten.

A zoological "station" is being commenced in the Department of the Eastern Pyrenees, and will be opened next winter.

According to a communication made to the Academy of Sciences, M. J. Chatin has detected Trichinæ encysted in the intestinal coats of the pig, as used for sausage-skins.

Messrs. L. Reeve and Co. are about to publish a complete illustrated work, by Dr. H. C. Lang, F.L.S., on the Diurnal Lepidoptera of Europe.

Dr. Seubert has determined the atomic weight of platinum as 194·46124, instead of the formerly admitted value 197·4. This change brings platinum into harmony with the requirements of the periodic law.

It is rumoured that a process for melting and forging iridium has been exhibited before the Scientific Society of Cincinnati. A bar of this metal, used in place of the negative carbon in an electric lamp, showed no loss of weight after burning for sixty hours.

The subject of colour-blindness as a possible cause of disasters at sea and on railways is attracting increasing attention.

C. W. C. Fuchs, in the "Naturforscher," gives a general summary of earthquakes and volcanic outbreaks for the year 1880. They appear to have been exceptional both in number and violence.

According to the "Baptist Family Magazine" (American) J. A. Parker's formula for the ratio of the diameter of a circle to the circumference is identical with the one "used by the architect of the Great Pyramid in its construction, and also by Moses and Solomon in the construction of the Tabernacle and Temple and their contents."

Prof. J. Collett, the State Geologist of Indiana ("Clinton Herald"), contends that the mastodon must have survived down to very recent times.

Prof. H. J. Detmers ("Science") traces the disease known as "swine-cholera" to a microscopic schizophyte, which is absent in healthy animals. The author points out a method of protecting swine against the disease by a species of vaccination.

Mr. C. H. Barton ("Victorian Review") summing up the disastrous phenomena, meteorological and otherwise, of the year 1880, which he terms "Annus mirabilis," draws the soothing conclusion that the earth is yet "instinct with vital energy," and betrays an exuberance of cosmic power not easily reconcilable with planetary old age. It might, however, be contended that the bulk of the disasters enumerated, being due to the want of heat, are by no means a proof of exuberant energy, but rather of

the decline of that which in the world corresponds to vitality in the individual organism.

Microscopic Notes.—The influence of the diffraction spectra in the formation of the microscopic image has a far greater bearing on the subject of errors of interpretation than might be supposed by the mere casual observer. If a diatom, such as *Pleurosigma angulatum*, is viewed with an objective sufficient to resolve it, and the eye-piece removed, upon looking down the tube a minute spot of light—a reduced image of the lamp-flame—occupies the centre of the field, and around it, at the extreme margin, six equidistant bright specks: these are the diffraction spectra of the object in question, which is acting like a ruled grating. If a central stop be placed in the diaphragm of the objective so as to cut off the dioptric beam, the diatom will appear with its markings resolved, but on a black ground; but if the diffraction spectra be intercepted by means of a marginal stop, the diatom will be seen on a light ground, but its markings will no longer be visible. By using a slit so arranged radially as to include one of the diffraction spectra, the dioptric beam-lines will appear at right angles to the radius; and by rotating the stop so as in turn to include different spectra, the direction of lines may be changed at pleasure. This is one of the results of the investigations of Prof. Abbe, of Jena, and the whole question of the "Function of Aperture in the production of Microscopic Images" will be exhaustively dealt with in a paper in preparation for the Royal Microscopical Society. It would seem probable that every transparent tissue may, to a greater or less extent, act on the illuminating pencil as a diffraction grating, and consequently produce spectral images: what their influence may be upon the image formed in the microscope can only be ascertained by a careful study of their action. Experiments with ruled lines have shown that, by using some of the spectra and excluding others, appearances totally false may be obtained at will, even the actual known direction and the number and distance of ruling of the lines being changed. These facts throw very great doubt upon the truth of all high-power observations, and it seems probable that a careful examination of the diffraction spectra of various tissues, with observations of the manner in which the appearance of minute structural details undergoes change, will be necessary, as a means towards the elimination of errors of interpretation, which the results of the researches of Prof. Abbe can leave no doubt exist in the whole of our past high-power observations by means of transmitted light.

The number of the "Journal of the Royal Microscopical Society" for April contains two important papers on the "Aperture" question: one by Prof. Abbe, of Jena, on "The Estimation of Aperture" (a profitable abstract would be almost impossible, but the paper deserves careful study by those who

would make themselves acquainted with the most recent discoveries in microscopical optics. The other paper is by one of the Secretaries of the Royal Microscopical Society, and is entitled "Notes on Aperture, Microscopical Vision, and the Value of Wide-angled Immersion Objectives." Mr. Crisp's object is to collect the scattered matter on the subject, some of which is printed, but the greater part exists in letters written by Prof. Abbe to Mr. Crisp and others. Pending the publication of an exhaustive treatise now preparing, these notes are of great value, especially as most erroneous opinions respecting both the aperture question and the whole theory of microscopical vision are widely disseminated; and it is to be hoped that Mr. Crisp's notes may be reprinted in a form accessible to those who do not see the Society's Journal. The paper occupies between forty and fifty pages, and, like Prof. Abbe's, could not be abridged. A number of important experiments with the diffraction spectra are described, and the microscopist would do well to repeat and carefully study them, as their bearing as to what is really seen through the microscope suggests the gravest doubts whether certain objects, such as the markings of diatoms, have been seen at all. The results of tampering with these diffraction spectra by stopping out some and using others, are remarkable, even to the total change in the appearance of an object the nature of which is perfectly known, *e.g.*, a series of ruled lines. Both their direction and their apparent number are capable of being changed, according to the diffraction spectra allowed to take part in the formation of their image.

ERRATA.

Page 273, line 23, *for* "suppositious" *read* "supposititious."

Page 303, line 3 from top, *for* "personal ties" *read* "personalities"; line 13, *for* "Reichert and Goethe" *read* "Reichert and Goette."

NOTICE.

Several important books, awaiting notice, stand over from want of space.

Mr. J. Hepburn Davidson's article on "Sham Employers" is delayed owing to the illness of the author, but will appear in our July issue.